The Pioneer Electrical Journal of America.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited

41 PARK ROW (TIMES BUILDING), NEW YORK.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.

(Including Postage in the U. S., Canada or Mexico.)

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THE ELECTRICAL WORLD,

41 Park Row, New York,

OR ANY OF THE BRANCH OFFICES.

VOL. XXII. NEW YORK, DEC. 9, 1893. NO. 24.

CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 439
ILLUSTRATED ARTICLES:
Technical Education in Europe—V., by Frank C. Perkins ... 440
Laboratory Notes—XII., by Lieut. F. Jarvis Patten ... 441
THE ELECTRICAL WORLD at the World's Fair ... 443
The Calculation of Alternating Current Motors—IV., by E. Arnold ... 441
How Galvanometer Coils should Be Wound—II., by Edwin F. Northrup ... 446
Digest of Current Technical Electrical Literature, Compiled by Carl Hering ... 447
Exhibit of the Buckeye Engine at Milwaukee ... 450
An Adjustable Desk Light ... 450
A Continuous Station Switch ... 450
Improved Fuse Block ... 450
MISCELLANEOUS:
The Economical Installation of Small Lighting Plants, by J. B. Cahoon ... 440
Meeting of the New York Electrical Society ... 444
Storage Batteries for Central Stations, by C. O. Mailloux ... 449
The Hydro-carbon Suit ... 449
Electric Heating for Street Cars, by Edwin B. Wyman ... 450
FINANCIAL ... 451
NEW INCORPORATIONS ... 451
SPECIAL CORRESPONDENCE: New York Notes, 451; New England Notes, 452; Western Notes, 451; Canadian Notes, 451; English Notes, 451.
NEWS OF THE WEEK: Electric Light and Power, 451; The Electric Railway, 453; Miscellaneous Notes, 453.
TRADE AND INDUSTRIAL NOTES ... 453
BUSINESS NOTICES ... 453
OUR ILLUSTRATED PATENT RECORD ... 454

Three-Wire Transformers. LIEUT. CAHOON refers in another column to a three-wire simple alternating current system which doubtless will find an extended use for smaller plants. As will be seen, the system consists of a transformer, from the middle point of whose secondary a third wire is led, thus applying the same principle used in the Edison three-wire system As the employment of the system necessitates the use of a secondary street system of wires, and therefore a largely increased amount of copper, it is evident that for large plants the increased cost of copper would be very great—perhaps very much more so than justified by the greater transformer efficiency.

The Three-Wire Patent. OUR attention has been directed to the claim made in some localities that a three-wire convertible system—that is, one in which three wires are installed, and two used as one lead in a two-wire system—is an infringement of the Edison three-wire patent. This, of course, is not true, as the three-wire patent is based upon a third wire used as a neutral or compensating wire and not upon the mere fact of using three wires. An installation, therefore, does not infringe the Edison patent if three wires are employed provided that the third wire is not used as a neutral or compensating wire, and such a system may be wired up with lamps alternately connected to the wires of the double lead so that it may be converted into a three-wire system at any time when desired. Of course no one can convert such a system into the three-wire system except the licensees under the patent. The presence of three wire fittings, and of the third wire in a central position would not constitute an infringement if two of the connections are bridged, since, as before remarked, the patent is based solely upon the compensating property of the third wire.

The Digest. FROM the numerous gratifying commendations of THE ELECTRICAL WORLD'S Digest of Current Technical Electrical Literature which we receive, it is evident that this valuable feature is appreciated at its true worth and somewhat in proportion to the labor its weekly compilation entails. While its value to all electrical readers is very great, this is true in even a greater sense to the specialist, as it enables him to keep track of the work of others throughout the world which otherwise it would be almost impossible for him to follow through the score and more of foreign periodicals in different languages. Even should he take all the journals from which the Digest is compiled, the mere work of glancing through and estimating the articles would entail an expenditure of time that few are able to spare. A distinguished foreign electrician writes that he does not refer to the European journals until after he has read THE ELECTRICAL WORLD'S Digest, which he uses partly as an index from which to determine what articles to look up; and some of the foreign journals quote the Digest largely, instead of referring to the originals, which they receive, of course, several weeks in advance.

A Change of Form. WITH a view to the convenience of our readers in handling the paper, a new form has been adopted for THE ELECTRICAL WORLD, in which it will appear beginning with the first issue for 1894. The page will be considerably smaller, the dimensions being 9½ x 12½ inches, instead of 12 x 16 inches, as at present, Otherwise, beyond a few typographical modifications, the familiar features of the journal, now so well known in every part of the world, will remain unchanged. While the change will involve additional expense in producing the paper, the subscription price will remain the same, our desire being to serve the interests of the reader in this respect as we have endeavored to do in others, regardless of any reasonable expense. The change will enable us to mail the paper flat, so that its pages will be smooth when received, and its size will also permit the contents to be more easily scanned—an important advantage to the busy man. With this departure renewed efforts will be made to serve the interests of readers and to even increase the lead which THE ELECTRICAL WORLD has heretofore always maintained in the field of electrical journalism.

Technical Education in Europe. IN this issue we present accounts of three more European technical schools, one of which, the Electrical Standardizing, Testing and Training Institution of London, is of an unique character, uniting commercial work with teaching. As many of the electrical schools of this country provide for commercial and other testing work in their laboratories, this feature has long been a part of our principal electrical engineering courses. The remarks quoted from Prof. Thurston as to the different methods of technical education that prevail in Europe and America are very suggestive, but cannot be taken as approval by those who would make the manual operations of the laboratory and workshop the prime factors in such courses. If the object of a school is to prepare its pupils so as to enable them to immediately enter into practical work when graduated, such a system is perhaps the best, but to maintain it involves in many cases not only the subordination of the training of the higher faculties, but actually confines the graduate to the practical sphere for which he has been so well fitted, instead of the wider field which technical education, as distinguished from manual training, is supposed to fit him for.

The Efficiency of Steam Engines. THE efficiency of steam engines is referred to in so many different ways that it is always well to exactly define the efficiency meant. There are the thermo-dynamic or thermal efficiency, which is the percentage of heat disposable between the limits of working temperatures; the mechanical efficiency, or ratio between the mechanical work delivered and the indicated horse power; a comparative efficiency represented by the number of pounds of water per horse power per hour, which includes the working efficiency of the steam and may refer either to the indicated or brake horse power; finally, a comparative efficiency represented by the coal per horse power per hour burned, which thus also includes the efficiency of the boiler. To illustrate, we will assume an initial pressure of 200 pounds, an atmospheric exhaust and a mechanical efficiency of .85. The thermo-dynamic efficiency is then .20. Assuming further a working efficiency for the steam of 60 per cent. and a boiler efficiency of 70 per cent. we have a total efficiency of .102 referred to the water used and .0714 referred to the coal, which correspond to a consumption of 26 pounds of water per horse power per hour from and at 212° F. F., and 2.6 pounds of coal per horse power per hour containing 14,000 heat units—a fair result with an atmospheric exhaust and with reference to the work actually delivered. From this it will be seen that if the mechanical efficiency were perfect the increase in the total efficiency would be only about 1¼ per cent., and that the greatest room for improvement lies in increasing the working efficiency of the steam. The case of a condensing engine was not taken in order to avoid an estimation of the work required for the condensing apparatus.

The Niagara Plant. THE Digest gives a full abstract of the first portion of Prof. Forbes' paper on the electrical features of the Niagara installation, which is the first publication yet made of the plans adopted and the reasons therefor. That the Cataract Construction Company should have sedulously concealed all knowledge of its plans from American electricians, in order, apparently, that Prof. Forbes might first give a European audience the benefit of the information, is rather peculiar in view of the fact that American capital furnished the means and the system adopted is American, as well as the territory to be supplied. That our surmise rests upon tenable grounds is apparent from a statement in Prof. Forbes' paper that he had been "desired by the president of the company to take this opportunity of stating some of the events which have culminated in the present satisfactory position of the company with regard to its contracts of machinery" which were awarded besides to an American company. The discussion of the relative merits of the two and three phase systems is of great interest, as well as that of the question of frequencies. As relates to the claim that there is a saving of wire in the use of the three-phase system over the two-phase, Prof. Forbes finds that this is not the case. Assuming that the same effective E. M. F. is used in both systems, it can be shown that the saving of copper in either is 25 per cent. over a simple alternating current system, but Kapp recently showed that if the stress on the insulation were considered the three-phase, for the same effective E M.F. has the advantage. It is quite probable that the friends of the system so strongly condemned on other points also will be heard from in reply. Altogether the views set forth, particularly with respect to the frequency, are radical, but as the subject is a new one and has received the most careful and elaborate study, it does not follow that they will not be entirely justified in practice.

Tesla's Steam Engine. IN another column we print in full the remarks of Mr. Tesla at the last meeting of the New York Electrical Society, in which he describes the principles of his vibratory steam engine, designed for the generation of alternating currents by apparently a similar method to that Edison had in view when he designed his "tuning fork" dynamo. From the description, which is rather obscure, it seems that the coil moving in the field of force is inclosed with the vibrator so that the friction of stuffing boxes is entirely done away with, thus enabling, it is claimed, a mechanical efficiency of 99¾ per cent. to be attained instead of 82 per cent. with the usual forms of steam engines—a very low figure. The thermodynamic efficiency, of course, will follow the same law that applies to other steam engines, since it depends only upon the initial and final temperatures of the steam. In view of the fact that it is proposed to use very high pressures in this engine, 350 pounds to the square inch being named, the claim that with it twice as much electricity may be generated from a pound of coal, than at present, is not unreasonable in connection with the high claim for mechanical efficiency, provided that the working efficiency of the steam is also increased. In order to obtain the high output referred to it is evident that very high frequencies are contemplated, and from lack of data a conclusion cannot be drawn as to the practicability of the engine for the ordinary frequencies of to-day. The effect of impedance with high frequencies, and the working efficiency of the steam in the proposed engine, are two points that occur which may affect the efficient working of the system, and it is hoped that a practical engine will soon be constructed on a large enough scale to demonstrate particularly the latter one and the various novel mechanical considerations that enter into the case.

The Economical Installation of Small Lighting Plants.

BY J. B. CAHOON.

A careful investigation of the small electric light plants throughout the country will show that many of them are only just barely clearing expenses, without netting any profit to the owners; as many more are running at a loss, while a very few are a source of profit. One fault of these stations which tends to make them non-profitable is the lack of economy in their operation. By economy we mean a true spirit of economy, and not a spirit of parsimony which sometimes passes for economy among the people who have considerable to do with electric properties. But leaving this out of the question, if we take a very small plant, say one running 600 or 700 incandescent lights, and try to run this at a profit in a country town, we find that, handling this as best we can with the old methods, there is little or no profit derived from its operation, especially if we charge off a certain percentage for depreciation each year. Now let us look into this a little more closely and see if we can ascertain why such a plant should not yield a fair return on the investment. In the first place, situated as our plant is in a country village with its long, straggling streets and extensive distances to cover, with only an occasional store, and here and there a light to be placed on the highway, if we run the two-wire system and use the direct current incandescent machine, we find that we are using a great deal of copper to maintain the required service, and that the cost of this copper is so great that the return for the use of the few scattered lights is insufficient to pay a fair rate of interest on so much copper.

We can resort to the alternating current and distribute at a potential of 1,000 or 2,000 volts, as the case may be, and so cover the main points to be lighted at a fairly reasonable outlay, but this will necessitate the use of a large number of small transformers, which means the production of light at a less efficiency and greater expense than if we could make use of large transformers. This will, however, furnish us with an incandescent system of lighting from which we can hope for some return on our investment. Or, we can install an arc plant which will enable us to distribute lights over the required area, and this will be perfectly satisfactory for street lighting and for use in some large buildings and stores, but it will not meet the demand for lighting private houses, small stores, and the various odds and ends which are liable to require light; therefore it is questionable if the arc light plant will be a profitable one, as it cannot contract for any of the small installations and practically will only serve to light the town. Again, as we start with the assumption that the town is too small to warrant the installation of both arc and incandescent circuits, it becomes necessary to decide upon some plan which will meet all conditions in a fairly satisfactory manner. After carefully watching the operation of alternating circuits with three-wire transformers I am convinced that this three-wire transformer system is the one which will be the most profitable to install in such places as mentioned above, as well as in larger towns and cities where distribution is to be made at long distances from the central stations and over a considerable area.

The system is an extremely simple one and is well illustrated by the plant of the Peterborough Electric Light and Power Company, Peterborough, N. H. In brief, the idea is to place large transformers at certain points, which may be called the centres of distribution for the area in which said transformers are situated, carrying the primary to those transformers at 1,000 to 2,000 volts and running off three wires from the secondary coils and carrying these along the streets to the points where they are needed. The difference of potential between the two outside lines will be 104, and between the middle and outside lines 52 volts. We can then tap directly off these lines and enter any house or building that wants lights without the necessity of installing any small transformers; in other words, we have by following out this method as flexible a system for incandescent lighting as the three-wire system now so much used for direct current.

This method presents some remarkable features deserving the earnest study of those interested in such work, the principal being the great saving effected in copper over a two-wire system, and the saving effected by the use of large transformers over small ones. This also presents a system which is flexible to an extreme degree in that, as the demands for lights increase, and we reach the capacity of our transformer installed, we have but to put up another large transformer and we have another centre of distribution to cover the same area, or, if lights are wanted beyond a reasonable distance from our first transformer, by the installation of a second at this further point, we shall have very little loss in transmitting the current to it over the primary wire at 1,000 volts, so that we are ready to take a contract with any and every householder and furnish him with light at a price which shall be reasonable and which will prove as beneficial to the user as to the plant. It will be seen at once that this is one of the great features of such an installation. It is not necessary to skip anything, but to reach out and get all the business that there is in the whole town, and if this is done, I think I can safely assure the payment of a handsome dividend on the investment.

Technical Education in Europe.—V.

BY FRANK C. PERKINS.

PHYSICALISCHE INSTITUTE, UNIVERSITAT LEIPZIG.

The University of Leipzig is among the most celebrated in Europe. At the time of the writer's visit the total number of students registered was 3,322. Since 1867 a number of new buildings have been erected in the southeast suburb, including The Anatomie, Physical Institute, Chemical Laboratory, Zoological Institute, Physical Laboratory, Mineralogical Institute, Patheological Institute, the new Botanical Garden, and the extensive Municipal Hospital. The accompanying illustration, Fig. 1, gives a general view of several of these buildings.

The Physical Institute of the University of Leipzig ranks among the first in Germany. There are about 300 students in this department, taking courses in electricity and physics. The electrical and physical laboratories are under the direction of Prof. G. Wiedeman, who has held a position as professor of physics in the university since 1871.

The equipment of this institution is very well fitted for special study and experimental work in physics; but for courses in mechanical and electrical engineering the laboratory equipment is not to be compared with technical schools in Dresden, Charlottenburg, Hanover, and others already described.

The Laboratorium, Fig. 2, was built in 1873, and is well arranged. It contains a variety of delicate instruments of precision. Among the electrical machines used are several manufactured by Schuckert & Co., of Nurnberg, and other leading electrical firms on the continent.

The dynamos for laboratory practice include direct and alternating current machines of modern types, and a machine for electro-deposition of metals. The same motive power is used here as in nearly all other laboratories on the Continent. In this instance the power is derived from a gas engine of 5 h. p., manufactured by the firm Gasmotoren-Fabrik, of Deutz. The ammeters, voltmeters and arc and incandescent apparatus are similar to the instruments, lamps, etc., described heretofore in connection with other schools in Germany.

The instruction is given by means of lectures, recitations and laboratory practice. The department of pure physics is in charge of Profs. Ostwald, Wiedeman and Wislicenus. The instruction in electrical engineering and dynamo-electric machinery is given by Prof. Neumann. The study of mechanics is taken in charge by Prof. Mayer, and laboratory practice in physics, electricity and electro-chemistry under the direction of Profs. Ostwald and Wiedeman. The lecture hours, as well as those of laboratory practice, are from 8 a. m. to 8 p. m. The professors in charge of the above departments state that the student may shirk a great deal of the work provided for in these courses and still get through the institution, although, of course, the amount of real profit obtained depends upon the individual effort of the student.

K. K. TECHNISCHE HOCH CHULE ZU WIEN.

The Technical School of Vienna is situated near the centre of the city, on Technicker Strasse, overlooking that branch of the Danube River called Wien-Fluss.

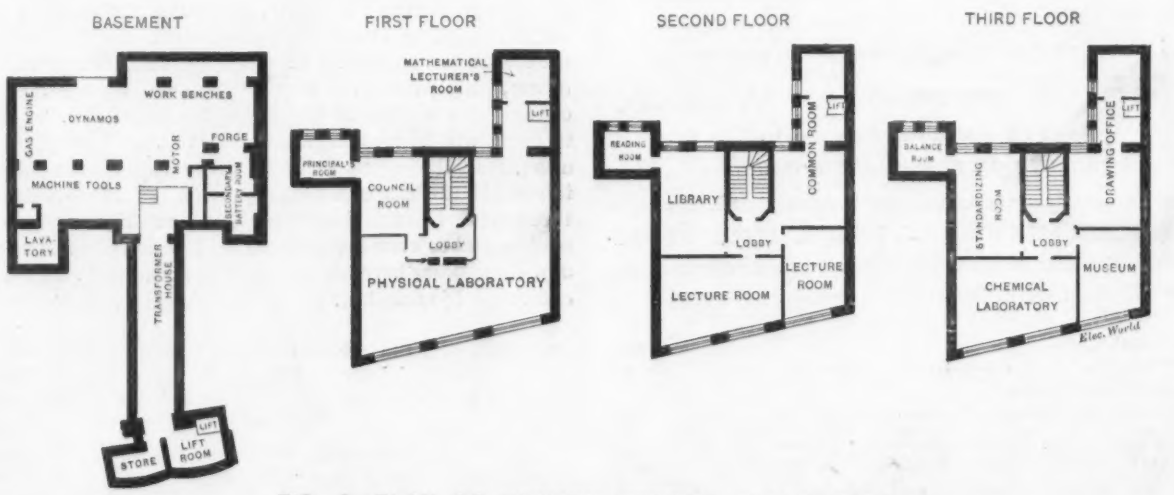


FIG. 5.—PLAN OF LONDON TESTING INSTITUTION.

The main building is a very imposing structure, as will be seen from the accompanying illustration, Fig. 3. In the garden, near the entrance, stands a very fine statue of Joseph Kessel, the inventor of the screw propeller.

The Technical Museum connected with this institution contains a collection of over 100,000 mechanical models, which are very interesting and instructive.

The equipment of the Polytechnical School is very good, and the laboratory compares favorably with those of other institutions on the continent.

The Technical School is not directly connected with the old University of Vienna, which is located on Universitat Strasse, and was founded in 1365. It has a faculty of 150 professors, and an attendance of about 3,000 students.

There are very few important polytechnical schools in Germany, Austria and France directly connected with the old universities. Dr. R. H. Thurston made the following statements in a paper entitled "Technical Education in the United States," which was presented before the mechanical section of the World's Engineering Congress, held at Chicago during the month of July, 1893: "In Europe, the custom has come to be almost universal to isolate the technical schools from the classical institutions and older universities. This has come about partly through the conviction that better work will be done by each class of college if allowed to work unhampered by the different methods, and even the conflicting views, feelings and traditions of the other; partly, perhaps, in consequence of their different foundations. Many able men favor both systems, and the amalgamation of the university and the technical school is likely to be given faithful trial here and there on the continent, and in Great Britain perhaps still more completely; but they are to-day practically separately administered in nearly all cases. The view of the relative importance of manual and of gymnastic training of the mind, which prevails generally in Europe, is that, in the higher schools of technology at least, the training of the hands constitutes no part of the essential education of the engineer even, and that these schools should confine themselves entirely to the instruction of the students in the principles of his art, avoiding the practice so far as it involves the use of the hands. It is perhaps a consequence of this belief and practice that the states of Europe have been, for years past, flooded with well educated untrained young aspirants for entrance into this vocation, who not only have been unable to find employment, but who have, in many instances, been informed by employers that they are not wanted. It is the man who suitably unites theoretical and practical knowledge and training who is wanted, and who best succeeds, in Germany, no less than in the United States. What foreign countries are doing in individual instances for the higher education may be understood from the statement of President Adams, that 'one of the minor universities of Great Britain has recently completed a collegiate building at a cost of £500,000,' and the Prussian Polytechnicum, at Charlottenburg, Berlin, represents four millions of dollars. The Zurich Polytechnic School has spent a quarter of a million of dollars on its chemical laboratory, and nearly as much in building its physical laboratory. The little Kingdom of Saxony, only one-half as large as Vermont, annually gives from its public treasury $400,000 to its university, although the institution itself has great wealth, and the professors are supported mainly by fees from the students."

Prof. Thurston further states, in reference to technical education in Europe, that "technical and trade education have for so many years been a part of the European systems of aiding manufactures that we may expect it to require many years to equal, much more to overtake them in the race. The effect has long been felt in the importation of skillful artisans and engineers from those countries to do work demanding the peculiar expertness coming of such scientific training. We have taken up our work in this direction none too early. It is difficult to realize the rate at which foreign nations are advancing in this direction, and how rapidly our own country is being distanced. It will demand the most earnest thought and the most energetic action on the part of those intrusted with the work of developing our educational system to prevent a very serious, if not disastrous, competition from abroad within probably the next generation. It is fortunate that the change has progressed in our own country even so far as it now has, and that its continued progress is assured."

THE ELECTRICAL STANDARDIZING, TESTING AND TRAINING INSTITUTION OF LONDON.

The officials of this institution claim it was established not only to fill a much needed want in providing standardizing and testing authority for the electrical supply companies of London, but because it was felt that the daily work of standardizing and testing carried out on

its premises would afford a unique opportunity for training electrical engineers.

It was founded by Mr. Robert Hammond. The laboratories and workshops, Figs. 4 and 5, are at Faraday House, Charing Cross Road, and are in charge of the principal, Mr. Hugh E. Harrison. The professors, in referring to their courses of instruction, compare the same with the following as two systems of training which are much in vogue elsewhere; they are called the workshop system and the college system.

The workshop system, which is a survival of the old practice of apprenticeship, consists of placing a lad with a firm of manufacturing or installing engineers and allowing him to work side by side with the ordinary workman. Such a course unquestionably gives a lad an insight into the working details that can be obtained in no other way; and when he finishes his work course he ought to have acquired a practical knowledge that

FIG. 1.—GENERAL VIEW OF UNIVERSITY OF LEIPZIC

FIG. 2.—THE PHYSICAL INSTITUTE.

at once enables him to earn a salary as a superior workman. Before, however, he can hope to fill higher positions. he must supplement the practical experience gained in the works by the acquisition of the knowledge of scientific theories which form the basis of all modern engineering, and especially those theories embraced by electrical engineering.

The college system, on the other hand, consists of the attendance upon lectures delivered by professional electrical engineers, and of the application to work, in the college laboratories and workshops, of the pure theory so taught. The defect, however, of the ordinary college system is this, that the college workshops are never quite like real workshops where serious work has to be done; nor is the college engine room like a central electricity supply station; with the result that, however

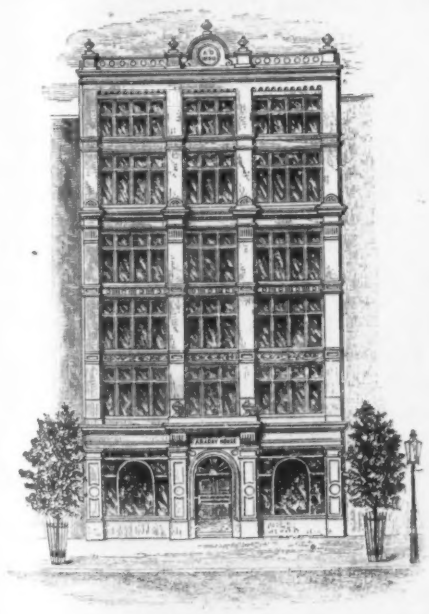


FIG. 4.—LONDON ELECTRICAL TESTING INSTITUTION.

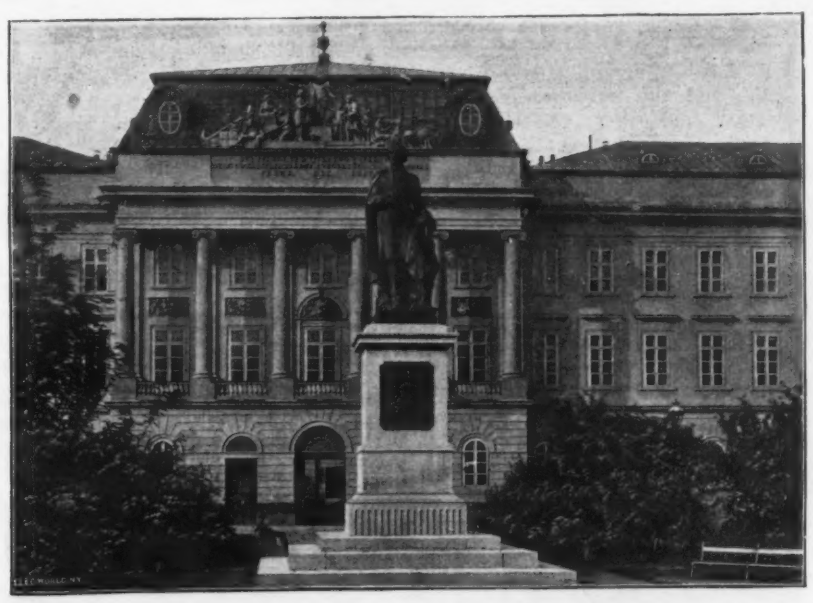


FIG. 3.—POLYTECHNICAL SCHOOL, VIENNA.

excellently a mere college or engineering school may be conducted, the student sooner or later has to supplement the theoretical knowledge there gained by serving as an improver at a works or at a central electricity supply station.

The defects of both systems are those of incompleteness, and an efficient training is to be obtained only by proper combination of both systems.

It has been stated that the training institution was established with the expectation of being able to supplement the ordinary college system by affiliation with the leading electricity supply stations of the United Kingdom.

The institution opens at 10 a. m. and closes at 5 p. m. every week-day except Saturday, when it closes at 2 p. m. The session is divided into three terms of nearly equal duration. The Michaelmas term begins in September and ends in December. The Lent term begins in January and ends in April. The summer term begins in April and ends in July. The attendance of the students on Saturday is optional, as there are no lectures on that day. The fees are 100 guineas per annum. The course of lectures last for one year, and the second year's course is devoted entirely to practical engineering work.

The lectures in electrical engineering are given by Prof. Harrison, on Tuesday and Thursday of each week, the following subjects being taken up for study: Electromagnetic induction; coefficients of mutual and self induction; arc lamps; incandescent lamps; theory of dynamo-electric machinery; transformers; accumulators; motors; mains; distribution of electrical energy.

The following subjects are taken up in the course of lectures in electricity and magnetism: Units; production of electrical effects; laws of electrical force; conduction; insulation; potential; induction; capacity; properties of magnets; production of continuous currents. Mathematics and physics, mechanical drawing and chemistry, were in charge of Profs. A. Russell, H. P. Powells and Charles J. Wilson. This institution owns a splendid library of standard works of reference.

Laboratory Notes.—XII.

BY LIEUT. F. JARVIS PATTEN.

THE PULSO-ALTERNATING CURRENT AND MOTOR SYSTEM.

The term pulso-alternating current is used to define a form which as the name implies is neither a pulsating current nor an alternating current simply, but both at once. A pulsating current I construe to mean one having a variable E. M. F., all the impulses however being of the same direction or sign, and having generally zero periods of appreciable duration, as in Figs. 19 and 20. An alternating current must have successive impulses of opposite sign or direction, and may have prolonged zero periods as in Fig. 22; or not as in Fig. 21.

A current like that pictured in Fig. 23 having two or more impulses of one sign followed by an equal number of opposite sign is the kind to which I give the name pulso-alternating current simply to distinguish it from the others mentioned.

This sort of current I have found interesting from two points of view: First, with regard to the method of generating it, and there are different ways of obtaining it as will be seen, and second, that it lends itself readily to a motor system, without commutator or brushes, that possesses novel features.

This form of current indicated in Fig. 23 is evidently the sum or resultant of two separate and distinct alternating currents of the kind shown in Fig. 22, so spaced with relation to each other that the pulsation of one occurs during the zero or idle period of the other. This is indicated in Fig. 23, where one is shown in heavy lines, and the other is dotted. It is also the same, in fact, as would result if every other pair of impulses of a single alternating current were reversed. Thus in Fig. 23, if the second and third, the sixth and seventh impulses were reversed, a single alternating current would be the result. The treatment of this form of current as two independent currents superposed or rather interspaced, for they are in no sense biphase currents, as will be shown, is more rational, as it does away with any commutating or reversing, and renders its production comparatively simple. It is generally much easier to imagine a form of current wave or a combination of them than it is to produce it. I was a little puzzled at first how to produce this current from an alternator single or compound, and I did not, in fact, produce it that way at first, but derived it from a direct current in a manner that will be referred to later on. The difficulty is to produce the extended zero period of the component, Fig. 22. Given this, their combining and interspacing is easy. The analysis, which seems worth giving, shows that not every form of alternator can be so arranged or constructed as to give a current of the form Fig. 22. Evidently it must be a machine that gives a maximum current at the time the wire is passing the field pole, and this is only the case with the type of alternator that has a ring winding or is of the general Gramme ring type. In all the others referred to as the Lontin or polar type, the current has a zero value when the armature poles are in line with the poles of the field, and as this period cannot be given any appreciable duration it becomes impossible to produce a prolonged zero period of the current wave as required.

Fig. 24 indicates a part of the field and armature of a multipolar alternator of the ring type. $A\,A$ is a part of the armature core, and c_1, c_2, c_3 represent the three different positions of a single turn of the armature winding in its passage from N_1 to N_2 and in the lower half of the figure the dotted curve $i_1\ i_2$ represents the varying rate of induction from the position N_1 to the position N_2, while the heavy line is the current curve, or curve of E. M. F. more strictly, which must be in quadrature with the curve representing the induction, as shown, for we know that the current is at a maximum, or greatest, when the "rate of change" of the induction is a maximum; and this rate is obviously greatest when the curve of induction is changing sign, or, in other words, is passing through zero. The current curve must, therefore, be at a maximum value when the other is zero, and conversely, as indicated in the figure. If, then, we desire to prolong or extend the zero period of the current, it means that we must keep the induction constant or, better, without any appreciable change during a corresponding period of time after the current curve is zero. In other words, there must be a prolonged period of no change in the induction curve immediately after that point where the current curve is at the zero line.

The graphic construction of this is shown in Fig. 25, where, as before, the dotted line, i_0, i_1, i_2, etc., is the curve which expresses the varying rate of induction, which, it will be seen, is undergoing change from i_0 to i_2, the point of greatest rate of change or steepest slope being at the point i, which must correspond to a point of maximum current, c_1; the rate then decreases more and more, or becomes less and less inclined to the zero line o, until, at i_2, the induction line is parallel to the zero line, which means no change whatever. The curve of current is then zero, and will remain so until further change of induction occurs. This begins at i_3 in the opposite direction; hence a negative current impulse, c_3, c_4, c_5 follows the next period of change, and so on.

Now to get the induction curve i_0 to i_5 we must so arrange the field that no lines of force are cut by the moving wire during the line corresponding to the period $i_2\ i_3$. Such an arrangement is roughly indicated in Fig. 24, which has been referred to already. In passing from the position c_1 to c_3, the armature coil is cutting lines at a maximum rate while passing the pole S_1, for here the induction is changing sign as the force lines are ceasing to thread through the coil in the direction

N_1 to S_1, and are beginning to thread the coil in the direction N_2 to S_2 in the opposite direction. But what was taking place at a period just before and just after the position c_1? We see that here the wire coil might move a considerable distance without altering the number of force lines threading through it; in other words, there must be here a more or less prolonged period of no change in the induction, hence a period of zero current, and we must infer, therefore, that the curve $_1 \ldots i_4$ of Fig. 24 is not in this case a correct representation of the induction rate for this particular case, but is only the general one sought after in most cases where it is desired to have the induction changing continuously. The current curve must also be wrong in Fig. 24.

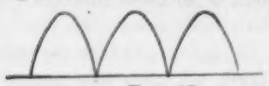


FIG. 19.

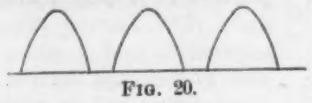


FIG. 20.

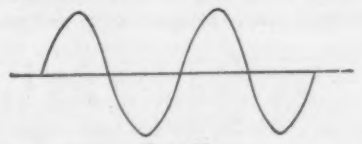


FIG. 21.

FIG. 22.

The curves in Fig. 25 are probably nearer to a true expression of the current that would result with a ring armature in a field the poles of which are spaced as in Fig. 24, that is, quite wide apart. Evidently they can be arranged in such a way that the active or current producing period and the idle period are equal. To get such a current, then, as that indicated in Fig. 23 it is only necessary to use two armatures and two fields arranged on the plan just outlined, put the armatures on a common spindle, and arrange the fields relatively to each other, so that the idle period of one armature corresponds to the active period of the other, care being taken, of course, as to the direction of current flow.

The general plan is indicated in Fig. 26, where F_1 and F_2 are parts of the two fields, A_1 and A_2 parts of the two armatures. The armature A_1 is in a position of activity, but A_2 is idle; as both move in the direction of the arrows this relation will change. One of these armatures, say A_1, will give the current indicated by the heavy line in Fig. 23, and the other will give that indicated by the dotted line of the same figure. These currents may, evidently, be led separately by distinct leads, m_1 and m_2, from the two armatures to separate translating devices, D_1. D, included in each circuit, and may afterward be combined in a common return lead, m_3. The leads m_1 and m_2 will have the separate currents, and the lead m_3 the combined current.

This arrangement would at first seem wasteful but if we consider the matter a moment we will see that this machine is little different from a simple alternator, a machine of high efficiency, for, as stated before, this peculiar form of current is to all intents a single alternating current, with every other pair of impulses reversed. It is, therefore, the equivalent of a single alternating current, and it will be seen upon examination that this form of double dynamo or generator is the equivalent of a single generator of the same total number of poles and armature coils, the only difference being that in order to get a particular effect or result we have taken every other field pole to a separate frame by itself and every other armature coil to a separate core, which enables us to divide the single alternating current we should have with the single machine in its ordinary form into a double current, of which we can make a more extended use. The whole system of generation, in fact, is a mere device, which alters the character of what would otherwise be a single alternating current, and gives us a double or split current of equivalent value without any commutating or breaking devices. We may recombine the effects of the two portions of the single alternating current and obtain a sort of rotary field motor system, which may likewise be without any commutators, rings or brushes, or without any current introduced into the moving part from the source of supply. Such a motor is shown in its simplest form in Fig. 27, and it differs in no respect whatever from a rotary field or Tesla motor operated by biphase currents, except that it is not operated by biphase currents and is entirely different in the principle of its action. Let this be considered for a moment, and to do this, suppose the ring winding supplied with currents in quadrature or biphase currents. Then, when the current in the circuit connected to the terminals a_1 + and a_1 — is a maximum, that in the other circuit, a_2 + and a_2 —, is zero, and a pole of certain strength is established on the vertical line. Now, with biphase currents supplied

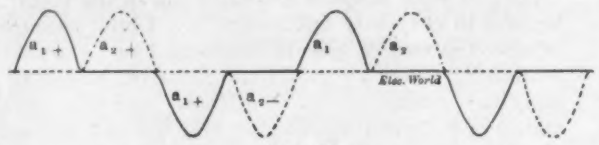


FIG. 23.

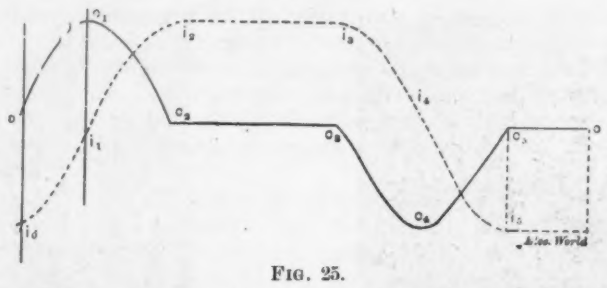


FIG. 25.

to this system, we find that as this first current decreases in strength, the other in quadrature with it, and in the circuit a_2 + and a_2 —, increases at the same rate, that the first diminishes and the effect of this change is to establish a polarity at some intermediate point between the vertical and horizontal diameters of the same strength as before, but on some intermediate line as P P in the figure. This is the true rotary field effect, and the polar line literally passes through each consecutive point around the ring. We obtain a very different effect with the system herein described, as should be expected, for we are dealing with a single alternating current after all, and the effect of the superposition of two independent but simultaneously existing currents cannot be had. Now let the motor system of Fig. 27 be supplied with the two currents of Fig. 23, that indicated by the heavy line being introduced at the terminals on the vertical diameter, and that indicated by the dotted curve on through the terminals on the horizontal diameter. We will then have in one complete cycle the following effects:

The pulsation a_1 + will make a polarity indicated by the arrow in the position N_1, and this will remain until that pulsation has entirely ceased. The pulsation a_2 + will then make the same pole as before at that extremity of the horizontal diameter, and the needle will turn to the position N_2. The negative impulse of the first current will then follow, entering at the lower point of the ring, will make again the same pole at this point, and the needle will move to the position N_3, and the negative impulse of the second current will then carry the needle to the position N_4, thus completing the cycle. Here, then, we have a different effect. The polar line jumps from point to point in the ring system in rotation; but passing, as it does, with considerable rapidity, the effect is similar to that of a rotary field. It is, however, not a rotary field in the true sense of the word; it is an entirely separate and different effect; and to what shall it be compared? It has its absolute analogy and parallel in direct current work. In fact, it is incorrect to compare such a system to a rotary field system at all, for it is identical with the effect produced by using a direct current with a collector, and with this current and system of distribution we can parallel the direct current machine in every particular with a divided alternating current and no commutator or brushes anywhere in the system. Let us suppose, for comparison, a fixed Gramme ring, with its collector, say, eight segments, arranged outside as in Fig. 28, and a closed circuited field or revolving part inside. Evidently if we send direct current to the brushes and cause them to revolve, the field will rotate, following the polar line of the brushes. Why? Because we have a revolving field? Not so. We have no revolving field whatever; but what we really have is a shifting field, which first is on the line, p_1 p_1, the present position of the brushes, and then it is on the line p_2 p_2, the position when they have shifted to the next diametrical pair of collector segments. It is precisely this effect that we have in the motor system of Fig. 27, when it is supplied with the pulso-alternating or dividing alternating current.

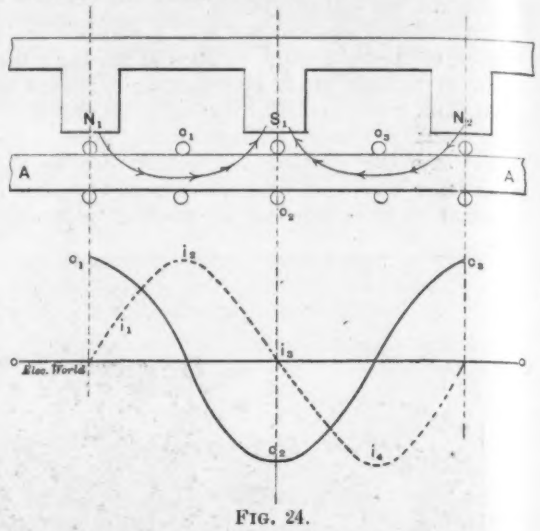


FIG. 24.

Of course the plan indicated in Fig. 27 is far from being the best way to make such a motor; it is only indicated in that way in order to facilitate the comparisons just made between it and the biphase machine and the analogous direct current machine.

The proper way to construct such a machine is to provide independent circuits for the two components of the pulso-alternating current and interspace them on the ring, so as to make a multipolar machine instead of a four-pole one, as indicated. This is equivalent to giving our corresponding direct current machine many collector segments, and so causing the polar line to shift but a small angular distance at each successive pulsation of current. And right here a singular difference from the ordinary multiphase machine (rotary field) appears. This type of machine requires only half as many poles in the revolving or induced part as there are in the field or fixed part. Thus in Fig. 27 we have a four-pole ring field, but only a two-pole or single magnet revolving part can be used to advantage; so, if we had a 16-pole field we should have an eight-pole revolving part only, and here we find in the motor system, or the translating devices, which may be many, some compensation or return for the loss incurred in making the generator for such a distribution system in the form of a double machine.

Before leaving this subject it is well to inquire how far the analogy goes between this system and the multiphase systems of higher orders than the second. In the latter we have shown that biphase, triphase and six phase require but three wires for transmission. Not so in the system here presented, for it is plain to see we must always have an independent lead for each component of the alternating current, and one more to act as a common return for all, so that a pulso-alternating current of n components will require $n + 1$ leads for its operation. In another respect, however, the analogy holds; for as in multiphase current working experience has demonstrated that little or no gain is to be expected from the use of higher phase currents, so in the system here illustrated it is plain to see that three or more components can offer no advantage over two, as with the latter we can make a multipolar system of any order.

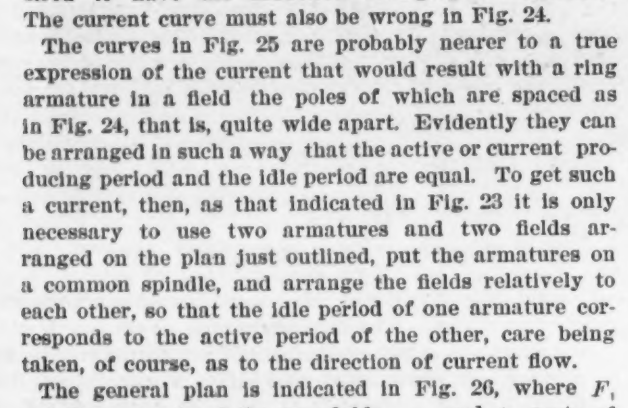


FIG. 26.

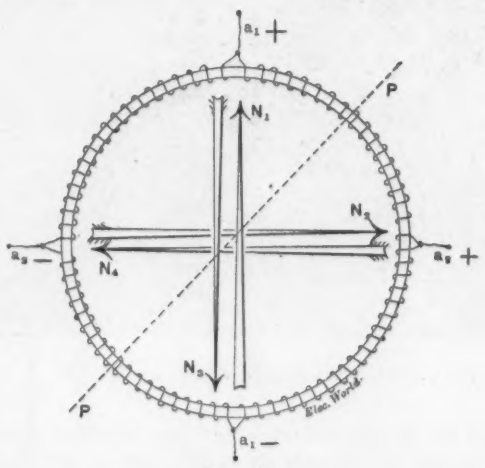


FIG. 27.

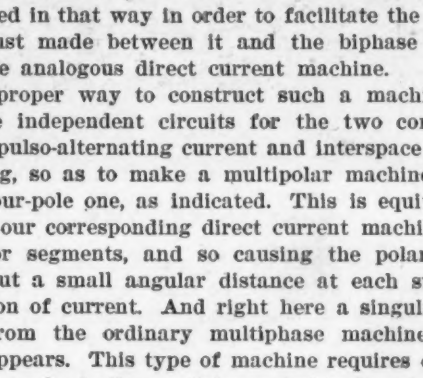


FIG. 28.

Experiments with this type of machine at my laboratory show that it has all the essential features of the biphase rotary field machine proper, as regards starting and operation. It is not necessarily synchronous, and slows down gradually under an overload. A feature of no slight importance is due to the nature of these single component currents with their extended zero periods which facilitate their rectification so that if desired they can be introduced as separate direct currents to two windings on the moving part. This gives the armature practically a direct current excitation, and if desired a series system of connections can thus be availed of. In this form the motor would present all the essential features of a fixed Gramme ring with an interior revolving field.

THE ELECTRICAL WORLD AT THE WORLD'S FAIR

CHICAGO 1893

With its characteristic modesty The Electrical World has reserved mention of the part which it took in the great World's Columbian Exposition at Chicago until after the many electrical displays and other features of interest to the electrical reading public have been fully described. This journal was not, however, by any means the least conspicuous of the exhibitors. It and its exhibit attracted the attention, not only of thousands who visited Electricity Building, but also of thousands of others to

A FAMILIAR SCENE.

whom, for one reason or another, this pleasure was denied.

To those who have watched its columns and noted the efforts which have been put forth to present in the most attractive form the salient points of the Exhibition, it must have been evident that The Electrical World from the first manifested unusual interest in this greatest of World's Fairs, and no other electrical, technical or engineering journal devoted so much attention or incurred so great expense for the accomplishment of this end.

Almost with the inception of the work, The Electrical World began to prepare for the fullest possible treatment of this important subject, realizing of what great moment the collection of so many evidences of the progress, wealth and resources of the country would prove and how beneficial and lasting its results would be upon the electrical, as, indeed, upon every form of industry. The W. J. Johnston Company, although it had favored its own city as the site, was the first firm in New York to subscribe to the World's Fair fund when Chicago was finally decided upon as the location, and thus pledging its earnest support to this vast national enterprise it continued to manifest the same hearty interest to the end, believing that the country as a whole could not fail to be substantially benefited by an Exposition of this character in which all industries and all sections cordially joined.

In the Northwestern Gallery of Electricity Building The Electrical World booth was pleasantly situated. It proved to be the most popular resort on Newspaper Row, if the long list of visitors which its register discloses, and the crowds continually present, may be taken as evidence, and shared the honors with the Headquarters of the American Institute of Electrical Engineers as the meeting place of electrical men. The accompanying illustration gives some idea of the appearance of the booth. It was cosily furnished, and provided with whatever was deemed necessary for the convenience and comfort of its visitors. The walls were adorned with some of the creations of The Electrical World's artist, the originals of many of the large illustrations which had from time to time appeared in the pages of the paper. The red canopy on the top served to distinguish it from the neighboring booths, and to lend warmth and color to the whole, although perhaps its most distinguishing feature was the fact that a courteous atendant was there to welcome and to attend to the wants of visitors. The Electrical World's register is, however, the most substantial proof of its popularity, and in its long list of names may be found not only those of almost all the electricians of note of this country who attended the Fair, but an unusually large proportion of the distinguished visitors from abroad.

The Electrical World's report of the World's Fair has spoken for itself, and requires no extended comment here. The pages of the journal for the past seven months, or we might better say the past 17 months, are a sufficient record in themselves. Commencing early in the summer of 1892, when the White City first began to assume definite shape and give some indication of its later beauty and grandeur, the series of illustrations and descriptions were inaugurated which made The Electrical World the most popular means of communication between exhibitors and readers. It not only presented matter in advance of its contemporaries—of which the descriptions of the Edison Tower and the Electrical Fountains are notable instances—but no pains or expense was spared to render its treatment of the electrical features of the Fair complete and attractive.

Even prior to the opening of the Exposition a representative of the editorial staff and The Electrical World's special artist went to Chicago, where they remained almost until the close of the Exposition. The profusely illustrated articles on the prominent electrical exhibits which appeared in these columns are too fresh in the minds of our readers to need mention, for all will recall the exhaustive and splendidly illustrated descriptions of the Electrical Fountains, the General Electric Company's exhibit, the Intramural Railway, the Western Electric Company's display, and many others of equal merit.

The International Electrical Congress, at Chicago, afforded another opportunity for The Electrical World to show its enterprise, and it is sufficient to say that seven of its representatives were present at the time, and its report of the Congress proceedings was by far the most complete and attractive published.

While from a commercial standpoint so lavish an expenditure of time and money may not have been justified, it is not for that reason to be regretted, for it is in accord with the policy of The Electrical World to present to its readers in the most interesting and instructive way the record of the principal events in the electrical field.

A FAVORITE RESORT.

WAITING TO REGISTER AT THE ELECTRICAL WORLD BOOTH.

The Calculations of Alternating Current Motors.—IV.

BY E. ARNOLD.

It has only now been possible for me to continue the communications which appeared in THE ELECTRICAL WORLD of May 13, 1893. In that section there are a few typographical errors which I wish to correct.

The last three equations should read :

$$I_2 = \frac{3}{2} \cdot \frac{p_1 M I_1}{\sqrt{R_2^2 + p_1^2 L_2^2}} \tag{31}$$

$$A_2 = \frac{9}{8} \cdot \frac{p_1^2 M^2 I_1^2 \cdot s_2 \cdot R_2}{R_2^2 + p_1^2 L_2^2} \tag{32}$$

$$D = \frac{A_2}{p_1} = \frac{9}{8} \cdot \frac{p_1 M^2 I_1^2 \cdot s_2 \cdot R_2}{R_2^2 + p_1^2 L_2^2} \tag{33}$$

Also in Fig. 6 the side $B\,c = \frac{3}{2} \cdot p_1\ L_1\ I$, instead of $p_1\ L_1\ I_1$.

We will now make the assumption that there is present only one primary and only one secondary phase, and that both coils are in the relative position of maximum mutual induction. The energy induced in the secondary coil by the first will then be :

$$A_0 = \frac{1}{2} \cdot \frac{p_1^2 M^2 I_1^2 R_2}{R_2^2 + p_1^2 L_2^2} \tag{33a}$$

Now in order to determine for this case the relation between the work A_0 and the primary E. M. F. we calculate the energy A_0 in functions of E_1.

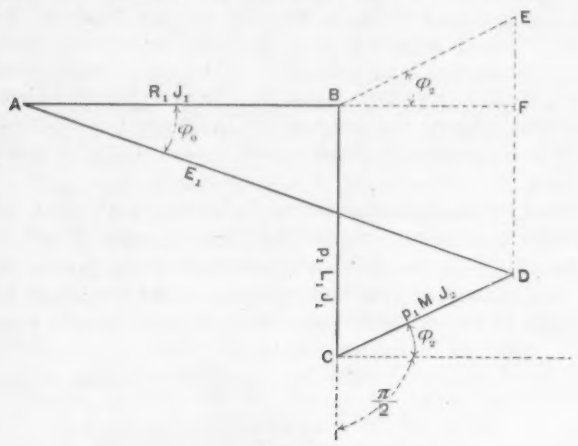


FIG. 7.

Then in Fig. 7 we make $A\ B = R_1\ I_1$, perpendicular to it.

$B\ C = p_1\ L\ I_1$ and at an angle $= \frac{\pi}{2} + \varphi_2$.

$C\ D = p_1\ M\ I_2$; then $A\ D = E_1$.

From the figure $E_1^2 = \overline{A\ F}^2 + \overline{F\ D}^2$, or

$$E_1^2 (R_1\ I_1 - p_1\ M\ I_2 \cdot \cos\varphi_2)^2 + (p_1\ L_1\ I_1 - p_1\ M\ I_2 \sin\varphi_2)^2 \tag{34}$$

where

$$\cos\varphi_2 = \frac{R_2}{\sqrt{R_2^2 + p_1^2 L_2^2}} \tag{35}$$

$$\sin\varphi_2 = \frac{p_1 L_2}{\sqrt{R_2^2 + p_1^2 L_2^2}} \tag{36}$$

$$I_2 = \frac{p_1 M I_1}{\sqrt{R_2^2 + p_1^2 L_2^2}} \tag{37}$$

and thus

$$E_1^2 = I_1^2 \left[\left(R_1 + \frac{p_1^2 M^2 R_2}{R_2^2 + p_1^2 L_2^2} \right)^2 + p_1^2 \left(L_1 - \frac{p_1^2 M^2 L_2}{R_2^2 + p_1^2 L_2^2} \right)^2 \right] \tag{38}$$

If to abreviate we make

$$q = \frac{p_1^2 M^2}{R_2^2 + p_1^2 L_2^2}$$

and put the value of I_1^2 from equation (38) in equation (33a), then

$$A = \frac{1}{2} \cdot \frac{p_1^2 M^2 E_1^2 R_2}{(R_2^2 + p_1^2 L_2^2)[(R_1 + q R_2)^2 + p_1^2 (L_1 - q L_2)^2]} \tag{39}$$

Also

$$q = \frac{M^2}{\left(\frac{R_2}{p_1}\right)^2 + L_2^2}.$$

The number $R_2 : p_1$ being small can be neglected in practice. Then

$$q = \frac{M^2}{L_2^2}.$$

But $M : L_2$ indicates the transforming ratio between a phase in the inducing and a phase in the induced current winding, assuming that every line of force of the primary system cuts the secondary system. For instance, if the induced circuit consists of s_2 coils (instead of simple windings, as are considered in Fig. 5), and every coil consists of z short circuited windings in series, then

$$\frac{M}{L_2} = \frac{s_2}{z}$$

R_2 thus represents the resistance of the z windings.

But as the primary and secondary windings are on separate iron cores, between which there is an air space, there will be a considerable leakage of lines of force. While the armature is at rest when the motor is being started the leakage reaches its maximum, as the excitation of the field is then many times what it is when the motor is running at normal load.

The leakage is also greatly dependent upon whether drum or ring winding is chosen, and increases with the increase of air space between field and armature, with the increase of induction of the iron of the magnet and armature and the air.

If there were no scattering of lines of force then would

$$M^2 = L_1\ L_2.$$

Considering the leakage, we make

$$b^2\ M^2 = L_1\ L_2 \tag{40}$$

b representing the coefficient of magnetic leakage, and $b < 1$; and, furthermore,

$$L_1 = \frac{4\pi \cdot s_1^2}{10^9 \cdot \rho} \tag{41}$$

$$L_2 = \frac{4\pi z^2}{10^9 \cdot \rho} \tag{42}$$

where ρ stands for the resistance of the magnetic circuit; and so we find that

$$q = \frac{b^2 L_1 L_2}{L_2^2} = b^2 \cdot \frac{s_1^2}{z^2} \tag{43}$$

If we now divide numerator and denominator in equation (39) by p_1^2, and neglect the member $R_2 : p_1$,

$$A_0 = \frac{1}{2} \cdot \frac{b^2 \cdot E_1^2 \cdot \frac{s_1^2}{z^2} \cdot R_2}{\left(R_1 + b^2 \frac{s_1^2}{z^2} R_2\right)^2 + p_1^2 \left(L_1 - b^2 \frac{s_1^2}{z^2} L_2\right)^2} \tag{44}$$

for $b = 1$; that is, when there is no magnetic leakage the second member of the denominator becomes zero. As this member is proportional to the square of p_1, and as we have b^2 in the numerator, this equation shows us that the energy A_0, and therefore also the torque, is greatly diminished by the magnetic leakage. This equation also shows us that the torque is proportional to the square of the primary tension E_1, that it is dependent upon the grouping of the armature windings (the total number of which $= s_2 \cdot z$), the sum of the armature resistances, $s_2 \cdot R_2$, and the transforming ratio $s_1 : z$.

The equation (38) can also be written in the following form :

$$I_1^2 = \frac{E_1^2 (R_2^2 + p_1^2 L_2^2)}{p_1^2 (R^2 L_2^2 + R_2^2 L_1^2 + 2 M^2 R_1 R_2) + p^4 (L_1 L_2 - M^2)^2 + R_1^2 R_2^2}. \tag{45}$$

If we now substitute this value of I_1 in equation (33a), and neglect $R_1^2\ R_2^2$, which is small,

$$A_0 = \frac{1}{2} \cdot \frac{b^2 \cdot E_1^2 \cdot R_2}{\left(R_1^2 \frac{L_2}{L_1} + R_2^2 \frac{L_1}{L_2} + 2 b^2 R_1 R_2\right) + p_1^2 L_1 L_2 (1 - b^2)^2}. \tag{46}$$

For $b = 1$, in case of no leakage, the second member of the denominator $= 0$; the member

$$R_1^2 \frac{L_2}{L_1} + R_2^2 \frac{L_1}{L_2} + 2\ R_1\ R_2$$

becomes a maximum for a particular relation of $L_1 : L_2$, namely, for

$$\frac{L_1}{L_2} = \frac{R_1}{R_2},$$

or for a transforming ratio,

$$\frac{s_1}{z} = \sqrt{\frac{R_1}{R_2}}, \tag{47}$$

or for

$$R_2 = R_1 \cdot \frac{z^2}{s_1^2}. \tag{47a}$$

Thus if we make the assumption that b nearly equals 1, so that the second member of the denominator can be neglected, then for the above transforming ratio or for the resistance R_2 given in equation (47a), the torque at the starting of the motor becomes a maximum. Now as s_1 depends upon the primary E. M. F., and, supposing the dimensions of the core to remain the same, increases with E_1, then the rational construction of the closed circuited armature becomes dependent upon the primary winding.

The dependence of the torque upon R_2 and the transforming ratio $s_1 : z$ can be best shown graphically. If we consider in equation (46) the quantities R_2 and $L_1 : L_2$ as the only variables, and let $b = 1$, then naturally A_0 becomes the torque.

$$D_0 = \frac{a_1\ R_2}{R_1^2 \frac{L_2}{L_1} + R_2^2 \frac{L_1}{L_2} + 2\ R_1\ R_2},$$

where a is a constant.

For $R_1 = 0.1$; $\frac{L_1}{L_2} = 10$; $\frac{s_1}{z} = \sqrt{10}$

we obtain with different values of R_2 the curve A, Fig. 8; for $R_1 = 0.1$; $\frac{L_1}{L} = 100$; $\frac{s_1}{z} = 10$, the curve B.

As R_2 increases the torque increases and reaches a maximum for a particular value of R_2 given by equation (47a). The resistance R_2 which corresponds to the maximum torque becomes smaller, the greater the transforming ratio $s_1 : z$; or with a constant resistance R_2, the torque increases with the increase of transforming ratio.

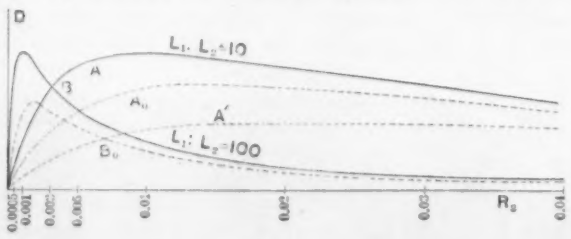


FIG. 8.

The magnetic leakage makes itself perceptible, as the torque is thereby lessened and the resistance R_2, which corresponds to the maximum torque, is increased. If we consider the leakage we will obtain instead of A and B the curves A_0 and B_0; or with heavy leakage A'. It is difficult to determine the exact form of these curves by calculation, as the value of the coefficient of leakage b is very variable. The smaller the armature resistance R_2, that is as we increase the amount of copper with which the surface of the armature is covered, the fewer will be the number of lines of force which penetrate the core of the armature, and consequently the smaller b becomes. Therefore the curves A and A_0 and B and B_0 respectively come nearer each other as R_2 increases.

Now to obtain an expression for the total torque produced by m primary and s_2 secondary phases, we make use of Fig. 9. As was done before in Fig. 6, we here make

$A\ B = R_1\ I_1$, and perpendicular to it

$$B\ C = \frac{m}{2} \cdot p_1\ L_1\ I_1,$$

$$C\ D = \frac{s_2}{2} \cdot p_1\ M\ I_1.$$

Then $A\ B = E_1$.

Furthermore in Fig. 10,

$$A\ B = R_2\ I_2,$$

$$A\ C = \frac{s_2}{2}\ p_1\ L_2\ I_2,$$

$$B\ C = E_2.$$

It follows that

$$\left.\begin{aligned} \cos\varphi_2 &= \frac{R_2}{\sqrt{R_2^2 + \frac{s_2^2}{4} \cdot p_1^2 L_2^2}} \\ \sin\varphi_2 &= \frac{s_2}{2} \cdot \frac{p_1 L_2}{\sqrt{R_2^2 + \frac{s_2^2}{4} \cdot p_1^2 L_2^2}} \\ I_2 &= \frac{m}{2} \cdot \frac{p_1 M I_1}{\sqrt{R_2^2 + \frac{s_2^2}{4} \cdot p_1^2 L_2^2}}. \end{aligned}\right\} \tag{48}$$

From Fig. 9 we deduce the value

$$E_1^2 = \left(R_1\ I_1 + \frac{s_2}{2} \cdot p_1\ M\ I_2 \cos\varphi_2\right)^2 + \left(\frac{m}{2} \cdot p_1\ L_1\ I_1 - \frac{s_2}{2} \cdot p_1\ M\ I_2 \sin\varphi_2\right)^2 \tag{49}$$

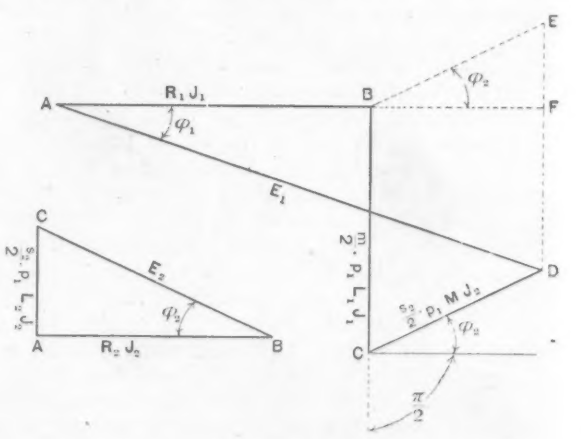
and

$$D = \frac{R_2 \cdot I_2^2 \cdot s_2}{2\ p_1} = \frac{m^2}{8} \cdot \frac{p_1 M^2 I_1^2 s_2 R_2}{R_2^2 + \left(\frac{s_2}{2} \cdot p_1 L_2\right)^2}. \tag{50}$$

Putting the value obtained in equation (48) in equation (49), and calculating I_1^2, it follows from equation (50):

$$D = \frac{m}{2} \cdot \frac{b^2 \cdot E_1^2 R_2}{p_1 \left(R_1^2 \cdot \frac{s_2 L_2}{m L_1} + R_2^2 \cdot \frac{m L_1}{s_2 L_2} + 2 b^2 R_1 R_2\right) + \frac{m \cdot s_2}{4} \cdot p_1^2 L_1 L_2 (1 - b^2)^2} \tag{51}$$

This equation is constituted similarly to equation (46).



FIGS. 9 AND 10.

For $b = 1$ the torque becomes a maximum when

$$\frac{m\ L}{s_2\ L_2} = \frac{R_1}{R_2} \tag{51a}$$

or for

$$R_2 = R_1 \cdot \frac{s_2 L_2}{m L_1} = R_1 \cdot \frac{s_2 z^2}{m \cdot s_1^2}. \tag{52}$$

(To be continued.)

Meeting of the New York Electrical Society.

The meeting of the New York Electrical Society on Wednesday, Nov. 29, was one of the most interesting which has taken place during its long career, the subject being "Electricity at the World's Fair and Its Lessons." The speakers were so well known and so eminently qualified to deliver addresses upon the subjects assigned to them that, as was expected, the attendance was large.

In the absence of the president the meeting was called to order by Mr. C. O. Mailloux. As Mr. Mailloux was on the programme for a brief address on "Storage Batteries," he opened the meeting with a few remarks on that subject. He stated that little had been done with storage batteries at the World's Fair, in fact the one interesting feature in which the storage battery played a part was the electric launches on the lagoons. But this application of the storage battery

did not involve any extraordinary features, and the conditions were not those which make the storage battery problem usually so difficult. The exhibits of storage batteries were rather meagre. There were three foreign displays, but with one exception they were little more than samples. This exception was an interesting battery in the Mechanic Arts Building, in the Russian section, which attracted attention on account of the peculiarity of construction rather than the results which it gave. In the French section a battery made on the Plante principle presented some features of interest. Among American exhibits there were three or four types of batteries which are already quite familiar. The exhibit of Mr. Pollak, of Frankfort, was instructive not only on account of the construction of the storage batteries themselves, but from the fact that it was shown in connection with a very ingenious device for commutating alternating currents for the purpose of charging storage batteries. This apparatus performs its work quite satisfactorily, and is not as complicated as one would expect. It consists merely of a system of rectifying the impulses. This was perhaps the most interesting exhibit relative to storage batteries shown at the Fair, as it suggested a new line of progress. It is in Europe that the most progress has been made in storage batteries, and while American manufacturers have been content to make batteries of two, three or perhaps four hundred ampere hours, in Europe it is current practice to use batteries of three, four and even five thousand ampere hours, weighing as much as two or three thousand pounds per cell. Another interesting feature at the Fair was an electric carriage, which suggested what we may expect in that line in the future.

Dr. Charles Emery was then introduced by the chairman and spoke briefly on "Electric Light Engines." He stated that there was nothing particularly new at the Exposition in this line; there was progress shown, but as a general rule it was more in the line of perfection in detail, increase in size and adaptability to special purposes. A large number of lantern slides were shown, and Dr. Emery described the salient features of each type.

Prof. F. B. Crocker was then called upon for remarks upon electrical congresses. He said that the recent International Electrical Congress at Chicago was remarkable in at least three respects. In the first place it gave final names and values to the electrical units. It is a fact that these definitions and values have been used before, but they had never been internationally accepted. The adoption of the name "henry" for the unit of self-induction is also another important result of the congress and a recognition both of the service of Prof. Henry and the work of Americans in general in this field. The third respect in which this congress equaled and perhaps surpassed all previous ones was in the importance of the papers and discussions brought forward there. The most important electricians of Europe as well as of this country were present, and this fact greatly added to the value of the work of the congress. As to future congresses, there was little left to be done; Prof. Rowland had said that he thought there would never be occasion to hold another congress, but this was perhaps going a little too far. Prof. Crocker thought that magnetic units and names for them, a standard of light and an international nomenclature for electrical terms and quantities would have to be taken up by some future congress.

The chairman here mentioned the fact that Prof. Crocker first suggested that the name "henry" be given to the unit of self-induction.

Mr. Nikola Tesla was then gracefully introduced by the chairman and spoke as follows, being allowed to exceed the 10-minute limit:

I have with great reluctance accepted these compliments, because I had no right to interrupt the flow of speech of our chairman. You may perhaps know, at least those of you who have followed the electrical development more closely, that the subject about which I am to say something is one which I recently presented before the Electrical Congress. During the past two years or so I have been gathering results and preparing work which I had in mind to present before the annual meeting of the American Institute as one of its members. But, as the date grew near, I found that the problems became so complicated and difficult that I could not do justice to the subject in this limited time, and so I made up my mind to drop the work for a little while, and go to the Exhibition and learn what I could, as any reasonable man would do. But the pressure at that time exerted upon me was so great that I could not resist when a number of scientific men urged me on to do something—deliver a lecture. A great many promised that they would come, but at the last moment they became ill, and when the programme was sifted down I was the only healthy man left, who had the time to deliver a lecture; and so I managed to take some of my apparatus, and through the courtesy of some officials of the American Express Company—especially Mr. Sherman, to whom I am indebted—was able to arrive in time, pretty nearly losing my opportunity by the impoliteness of one of the officials of the Fair; and so I gave a brief outline of this work.

Now, as a matter of fact, at that time I had gone considerably into the study of the practical aspects of the work which I was to present, and my notion was that I was touching upon something very important, something which would lead perhaps—so I thought in my enthusiasm—something which would lay the foundations of a novel industry, perhaps of more than one industry. But to speak in that strain before such a gathering as I had the honor to address there would have required a nerve which I did not possess, or if I did possess it it would be sure to leave me when I wanted to use it; and so I dwelt chiefly on those features which possessed a purely scientific interest, my desire being to present the subject very modestly, as I was not quite sure of some of the questions involved. Right after the lecture I asked one of my friends what he thought of it. He said it was well enough, but it could have been better. A prominent engineer came to me and said, "Mr. Tesla, I want to tell you something, but I fear it may offend you." I knew what was coming and so I asked what it was. He said: "Well, don't you work on steam engines. You have done some work in electricity. If you stick to it you will do some good work, but if you work on steam engines you are bound to fail." All these men that I mention are the most prominent men in the profession. Another said, "I wonder what Tesla is going to do with his blessed engine." Another, to whom I showed the advantage of doing away with complicated mechanism and generating electricity directly, said, after he had watched it for a long time, "Couldn't you apply this to rotating motion?" Now this is the way that my work was received. But I was quite prepared for that because for fully two years I had had these ideas in my mind. I rejected them and rejected them again and again, until I got in my mind the construction of the apparatus, until I overcame some difficulties which at first seemed to me insuperable, and finally I devoted myself to this work. One of the first impulses which guided me was to produce an absolutely constant motion, which would be independent of any friction losses, or gravity, or temperature changes within very minute limits. Now, you can employ a pendulum, you can employ a clockwork of a vibrating spring, or some such device as that. But they are very unreliable. I wanted to produce a positive motion, so that I might operate what I called some time ago a disruptive discharge coil. I may assume that some of you know that some time ago I advanced a method of producing currents of high frequency from direct or alternating currents. The method consists of charging condensers, discharging them either through a primary and then introduce devices in coils of the secondary or in its own current of high potential. Now the lamp to be operated with such coils is perfect enough. A nearly exhausted vessel would be good enough. But the devices themselves are inefficient in the production of these currents, and one reason was that these devices did not yield a perfectly constant vibration. I had to depend on a disruptive gap. I used air blasts, or oil streams, or a mechanical interrupter. Now with this device which I invented subsequently I was able to maintain a vibration with perfect constancy. This device consisted of a spring, which required several tons of force to spring a certain distance, and which was constantly kept in vibration by steam pressure or air pressure. In the beginning I used springs of tempered steel. These steel springs would break, though they had a section of two or three square inches. So I resorted to air springs. The air springs would not break, but they had no constant resilience. Then I made the chambers of the hair springs communicate with the outer air. Then I maintained boiler water around the jacket. Now you know this device yields a constant vibration, and as the force which is driving it is many tons and the friction but a very small matter, it is unaffected by the pressure, and so I have a constant vibration. This was one of the chief features I wanted to present. This is the device which I believe will be used for many purposes, for instance, governing all sorts of mechanism, engines and so on. This was one of the features which had interest for scientific men, because with this I am now enabled to produce currents of perfectly constant frequency. But this was merely the tail of the work which I have been doing. You have seen a few designs of engines described by the eminent speaker who is one of the most competent to talk on the subject, and who has shown us a great many complicated mechanisms. They are exactly adapted to illustrating what I have to say, and I would ask whether it is not worth while to attempt to simplify those mechanisms, which we have been using heretofore for the production of electric currents. When we look at a steam engine and inquire where the power comes from that drives the steam engine, we will always find that the power comes from a little box—a cylinder with a piston in it—and all the other appurtenances are really but to keep it going. You may do away with the flywheel, with the cross-heads, with the eccentrics, with all the appliances provided that you can in some other simple way govern the motion of the mechanism. So then my first idea was to apply the motion of the piston, which is freely movable, to a magnetic field, to move a magnet or a coil in a magnetic field and so generate currents by this direct motion. Now let us see what we can do in that respect. First, we reduce the weight of the engine for the same pressure and the same piston speed to one-thirtieth or one-fortieth if not one-fiftieth of its weight. Furthermore, we do away with all mechanical frictions. The engine designed according to my ideas has a mechanical efficiency of 99¼ per cent. Now that is in itself a very big item and renders it worth while endeavoring to make this mechanism a commercial success. But there are other far greater things. You will find that engineers often say what an advantage it is to apply the direct motion of the steam piston to a pump. In reality the advantage in a pump is but a very minute one. The water column has got an enormous inertia, and what we do gain in the direct acting pump is merely a matter of overcoming some additional frictions which we have in the ordinary engine. We may take the mechanical efficiency—I gather the data from various works—we may take the efficiency as say 81 to 82 per cent. at the full load. But the efficiency is much less on a varying load. Then, furthermore, we have got these variously estimated. I take the figures which I have found to be fair, giving this as the efficiency. Now the dynamo again has got mechanical losses due to friction, and, furthermore, the wire is never utilized fully in the dynamo. In my construction the dynamo may consist of a simple coil of the magnet, and a simpler coil which is all immersed in the magnetic field. There is no useless wire. Consequently dynamo and engine, if they are reduced considerably in weight, increase in efficiency. There is only one engine which can equal it in output, and that is the turbine. With the steam turbine we can obtain an enormous output, and that is the reason why the steam turbine, in my opinion, may be found a valuable adaptation for driving dynamos; and then convert the motion by means of alternating dynamos; and I think the steam turbine has in itself a physical cause why it cannot surpass a certain efficiency, and that is that we drive turbines by impact. A turbine might be very efficient if the medium which propels it were incompressible and homogeneous. But it cannot be efficient if we drive it by means of isolated shocks. Furthermore, we cannot in a turbine gain all the expansion. These causes, I think, will limit the efficiency obtained in turbines. But in reciprocating mechanisms we can, provided we obtain a sufficient high speed of the piston, expand the steam at an enormous rate. It is perfectly practicable in these mechanisms which I have been working up to obtain, if you want, a speed of 100 metres a second, and while I do not contemplate producing such speeds yet it is quite possible to do it. But since we can produce higher speeds we might as well increase the speed two or three times, and so augment the activity of the mechanism and raise the efficiency. Furthermore, as I am enabled now to work without a packing, I found that in these mechanisms the packing is actually objectionable, the expansion occurring at an enormous rate, and the engine being of such character that the exhaust can be reduced to pretty nearly the atmospheric pressure very easily. The mechanical friction is reduced to such a small figure that we can raise the temperature of the steam very considerably. You know that in high pressure steam engines one of the greatest troubles is the lubrication. We can go so far with the mineral oil, we can go so far with ordinary oil, but then we reach a point at which we cannot go any further, the lubricant will not work; and I am informed by very able practical engineers that about 250 pounds per square inch of steam pressure is as high as we practically go. With this engine we can go much higher. I am now preparing a boiler which will give me up to 350 pounds pressure. It is very important, of course, to get the pressure very high. In these mechanisms we are confronted with two things. For what are they going to be used—for light or for power? If we want to drive motors we must have a long stroke and a slow frequency. If we want to operate lamps then we want a very short stroke and a very rapid motion. To have a high speed with short stroke we must have a great initial pressure, because you know the number of vibrations increase only as the square root of the pressure. So if we want to have twice the number of vibrations we must have four times the pressure. But, on the other hand, four times the pressure and twice the number of vibrations means eight times the output. So it is very important in this mechanism in which the power depends on the square to obtain as high a pressure as possible. It is on this line now that I am working.

We have had such reciprocating engines as far back as 1868 or 1870, and it would be a very erroneous idea to think that I had evolved something radically novel in that part of the mechanism.

It is more economical to produce rapid vibrations than low vibrations. But so far as the economy of the dynamo is concerned, and so far as the economy of the engine in general is concerned, it is better to

produce a long stroke, because a long stroke means a high velocity.

I have an apparatus which runs lights in the laboratory, and shortly I think I will have something which will be ready for practical application. I think I am not mistaken in believing that we are going to have very shortly a means at hand of producing twice as much electricity from coal as we can produce at the present time—provided I am not mistaken. This is subject, of course, to a test, but I am quite confident that it can be done. This is not, however, a subject which occupies me altogether. There are also other subjects.

Mr. J. J. Carty was the next speaker, and his subject "The Telephone." He said that to give a proper idea of the telephone exhibit at the World's Fair would mean a review of the present state of the art of telephony, and this he did not propose to undertake. The foreign manufacturers had little to show of interest or novelty. The general features of the display were interesting more from the tendencies which they exhibited than from any details of structure, and the latter work in this line has been confined more to doing things which we know how to do, and doing them well, than trying to find out things which we do not know. The long distance line from Chicago to New York was perhaps the most striking exception presented. The movement has lately been away from series work toward multiple arc work. The exhibition of American underground cables was particularly complete, and in this respect this country may be said to excel; the material generally used is paper put loosely upon the wires so that the dielectric is really a mixture of paper and air. This gives a very low capacity, and is specially suited for telephonic purposes.

Mr. James Hamblet next spoke upon the subject of "Electric Clocks." About 10 years ago the first decade of standard time in this country was completed. Electric clocks were first exhibited in the exposition of 1851, but with small success. The kind of clock then used was driven entirely by electricity, but within a few years inventions have been brought out by which the clock is simply wound by electricity at stated intervals. The Self-Winding Clock Company is making arrangements with the Western Union Telegraph Company to introduce these clocks to all the large cities of the United States, and they have something like 20,000 already in operation. An elaborate exhibit of these clocks was made at the Exposition. They were scattered all over the grounds, many of the buildings containing a number; they were all wound once an hour and corrected every hour by a fine standard clock, which in turn was corrected daily by a signal from Washington. One of the newest features in the exhibit was the tower clock in the middle of the Manufactures and Liberal Arts Building. Such a clock makes it possible to dispense with the cumbersome weights and mechanism of the ordinary tower clock.

A motion to postpone remainder of programme until some future date was made and carried.

Mr. Hamblet then exhibited a collection of views showing the principal features of the World's Fair.

Dr. Emery also made a few remarks supplementing his address earlier in the evening, in which he called attention to a steam turbine exhibited in the Danish section, which ran as high as 20,000 to 30,000 revolutions per minute, and delivered 20 h. p. with a wheel about four inches in diameter at an efficiency of perhaps 80 per cent.

Mr. Tesla then stated that he did not mean to say that the turbine is mechanically inefficient, but what he meant was thermic inefficiency.

Before the adjournment a vote of thanks to the gentlemen who had favored the Society with remarks was unanimously passed.

How Galvanometer Coils Should Be Wound.—II.*

BY EDWIN F. NORTHRUP.

Fig. 1 is a cross section taken through the axis of one pair of coils for a Thompson four-coil reflecting galvanometer. The right hand half of this diagram shows the theoretically best arrangement of the wire. The curves in dotted lines give in cross section surfaces of equal influence at the centre of the coil. That is, if a wire were to be wound upon one of these surfaces about the axis of the coil as at a centre, it would produce with a given current the same strength of field at the centre of the coil at what ever part of the surface it was wound. The equation of these curves is $r^2 = p^2 \sin \theta$, where r is the distance of any point upon the curve to the centre of the coil, θ the angle $P\,O\,M$ (see Fig. 1), and p a constant which is equal to the parameter of the curve taken.

It is not possible to fill the channel bounded by two such surfaces with wire of a given size, but the left hand half of the diagram gives in cross section the channels in which it is perfectly possible to wind wire. It will be observed that there are six spaces included between the curves marked A, B, C, D, E, F, and that these spaces are cross sections of channels of unequal depth, as measured along the centre radius of the whole channel, and that a is the empty channel or core of the coil. Now it is shown in Gray that, if y is the radius of any winding upon a surface with parameter p, as p is increased so should y be increased in a like ratio. But for practical purposes it is a close enough approximation to call these curves expressed by the equation $r^2 = p^2 \sin \theta$ circles, and to say simply that y should vary as the diameter of three circles, or that y should vary as the radius of the windings. But such winding could only be strictly followed by using a wire gradually increasing in diameter, which of course is not possible. Hence, in practice, an approximation must be made by changing at certain intervals the size of the wire. For a coil like that shown in the diagram the use of five different sizes of wire will give a sufficiently close approximation, and about as near a one as can be obtained with the different sizes manufactured. The diagram shows five sizes, with diameters increasing in nearly the same ratio as the mean radii of the different sizes. But here the changes from one size to a larger size are made at unequal intervals along the centre radius of the channel of the double coil. This has been done for the following reason: It is known that the influence of any turn carrying a unit current at its centre is inversely as the radius of the turn Hence, if the size of the wire in the coil were to be changed several times to accord with the theoretical size, and the changes were made at equal intervals from the centre of the coil, then those changes made near the centre would be of more importance than those at a distance from the centre. It is, however, desirable that the importance of each change should be about the same. To make this so the number of times that the size of the wire is changed in passing along the radius of the channel for a given distance should be inversely as that distance is from the centre of the coil. Thus, if the size of the wire is to be changed five times we may divide the radius of the channel into five lengths. Each length will represent the depth of the channel occupied by wire of one size and the lengths will bear to each other the same ratio as their mean distance from the centre of the coil.

Starting from the centre of the coil one can calculate the fine points along the centre radius at which the changes in the size of the wire should occur by the following simple formulæ: Let a, b, c, d, e be the largest radii respectively of the windings of each size of wire, a being the radius of the smallest size. Let D be the total radius of the channel. Then $a = \frac{1}{15} D$, $b = \frac{2}{15} D + a$, $c = \frac{3}{15} D + b$, $d = \frac{4}{15} D + c$, $E = \frac{5}{15} D + d$. But as the needle has a half length of $\frac{3}{16}$ of an inch, it is better, in order to bring a large number of fine turns near the ends of the needle, to make the first change at a greater distance than $a = \frac{1}{15} D$. (See Fig. 1.)

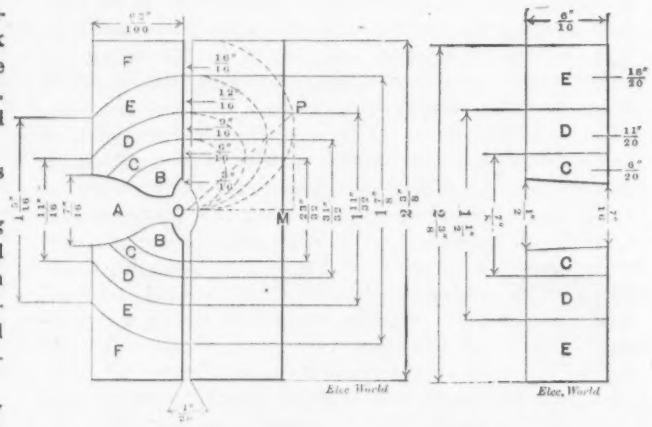


Fig. 1.
Cross Section through Axis of Coil Wound with Five Sizes of Wire.

Fig. 2.
Cross Section through Axis of Left Half of Coil with Three Sizes of Wire.

It is also shown in Gray that where a needle of a given length is to be used some of the turns, whose radii are less than half the length of the needle and which are close to the centre of the coil, must be left out, else they would have a reverse action to the rest of the coil. The right-hand half of Fig. 1 shows the space that must be left for a needle whose half length is three-sixteenths of an inch. The left-hand half gives the space which it is found in practice best to adopt. The space is made a little larger than the theoretical one because these turns which are just on the limit have little action, and also to allow more room in which the needle may swing. The small turns, some distance from the centre of the coil, have little effect, and as they would be practically so much dead resistance they are also left out. The figure shows the shape of the core that it seems best to adopt.

We will now give a formula for calculating the windings and sizes of wire to use in a coil like the one described so that such a coil may be wound to any desired resistance. As it is a laborious task making these calculations, several applications of the formula are also given.

The following formula may be derived from data given in "Electricity and Magnetism," by Mascart and Joubert, Vol. II., pages 82 and 83. The derivation of this formula is, however, quite lengthy and so we must refer the reader to the above reference. Let y = radius of bare wire of smallest size that is to be used. Let z = the thickness of its insulation and $\frac{z}{y} = \delta$. Also let δ_1, δ_2, δ_3, δ_4, equal the same ratio for the other sizes of wire. Let ρ equal the specific resistance of copper which is taken here as .0000006292 ohm. Let R = the total resistance that the coil is to have. Let u_1, u_2, u_3, u_4, u_5, be the respective volumes to be occupied by the five different sizes of wire. Then for a coil whose channel and other dimensions are in general like that shown in Fig. 1, we have, for the first size of wire to use,

$$y = \left\{ \frac{\rho}{4\pi R} \left(\frac{u_1}{(1+\delta^2)} + \frac{u_2}{(1+\delta_1)^2 a^4} + \frac{u_3}{(1+\delta_2)^2 b^4} + \frac{u_4}{(1+\delta_3)^2 c^4} + \frac{u_5}{(1+\delta_4)^2 d^4} \right) \right\}^{\frac{1}{4}}$$

Here a, b, c and d are coefficients by which y, the radius of the first size of wire, must be multiplied to obtain the radius of each of the other four sizes. In the application of this formula I have taken these equal to 2, 3, 4 and $\frac{16}{3}$ respectively. Thus, if the solution gives the radius of the first size to be 1 y, then the other four sizes would $2y$, $3y$, $4y$ and $\frac{16}{3} y$. These numbers are proportional to $\frac{3}{16}$ inch, $\frac{6}{16}$ inch, $\frac{9}{16}$ inch, $\frac{12}{16}$ inch and $\frac{16}{16}$ inch, which are the lengths of the radii, taken a little shorter than the mean radii of the windings of each of the five sizes of wire. (See Fig. 1.) Until the sizes of the wire to be used are known, δ, δ_1, δ_2, δ_3 and δ_4, which equal $\frac{z}{y}$, $\frac{z_1}{2y}$, $\frac{z_2}{3y}$, etc., are of course unknown.

Hence to solve the above equation it is necessary to first give δ, δ_1, δ_2, etc., each an arbitrary value such as zero, then to solve the equation, and after having carefully measured the thickness of the insulation with a micrometer screw of the sizes of wire so obtained to give δ, δ_1, δ_2, etc., values more nearly correct, and so, by two or three approximations, arrive at the correct result.

The following are the values of u_1, u_2, u_3, etc., corresponding to the left-hand half of Fig. 1:

Volume of $B = u_1 = .085$ cubic inch.
" " $C = u_2 = .132$ cubic inch.
" " $D = u_3 = .53$ cubic inch.
" " $E = u_4 = .74$ cubic inch.
" " $F = u_5 = 1.23$ cubic inches.

Following are the thicknesses of the insulation of a few sizes of wire made by different well known manufacturers. The covering is single silk:

Bradford Kyle's wire:
No. 42 (.002 inch) Z = thickness of covering = .0011 inch.
No. 38 (.0039 inch) Z = .00155 inch.

Imported wire:
No. 40 (.0033 inch) Z = .00195 inch.
No. 39 (.0035 inch) Z = .00175 inch.

American Electric Works' wire:
No. 36 (.005 inch) Z = .00175 inch.
No. 34 (.006 inch) Z = .0015 inch.
No. 32 (.008 inch) Z = .00125 inch.

It is seen from the above that the thickness of the insulation does not bear a constant ratio to the diameter of the wire, but is about the same for the different sizes. Hence the gain made by using finer sizes is not as great as it would be were this ratio a constant one.

I also give here a formula for a coil of simpler and cheaper construction wound with only three different sizes of wire, the channels of the different sizes having a rectangular cross-section. (See Fig. 2.)

$$y = \left\{ \frac{\rho}{4\pi R} \left(\frac{u_1}{(1+\delta)^2} + \frac{u_2}{(1+\delta_1)^2 a^4} + \frac{u_3}{(1+\delta_2)^2 b^4} \right) \right\}^{\frac{1}{4}}$$

Here $a = \frac{11}{6}$, $b = \frac{19}{6}$, which makes the different sizes $\frac{6}{6} y$, $\frac{11}{6} y$, and $\frac{19}{6} y$, which are proportional to the radii, $\frac{6}{20}$ inch, $\frac{11}{20}$ inch and $\frac{19}{20}$ inch.

The values of the volumes are:
$C = u_1 = .255$ cubic inch.
$D = u_2 = .694$ cubic inch.
$E = u_3 = 1.304$ cubic inches.

The calculations are necessarily all based upon the assumption that the wire is uniformly wound. This, of course, is not true, and hence the resistance of the coils will generally come a little below that calculated, when each size of wire is made to exactly fill the channel intended for it. If, however, it is important that the resistance shall come out exactly as intended, it may be made to do so by unwinding each size of wire, except the last, to the exact resistance calculated. The volume of the channel left unfilled may then be carefully determined (see Mascart and Joubert, vol. II., page 72), and the size of wire calculated, which, when used to fill this remaining volume, will have the required resistance to bring the total resistance out right. The length of wire in any channel whose volume is known is given by the formula $l = \frac{U}{D^2}$, where U is the volume and D the diameter of the covered wire. This formula also enables us to prove the correctness of our calculations without actually winding the coil, for we know the different volumes to be filled and our calculation has given us the different sizes with which these volumes are to be filled to produce a given total resistance. Hence we can determine the length of each size of wire and then by referring to a table of resistances determine the resistance of each size. If the sum of the resistances of the different sizes is equal to the total resistance that the different sizes were intended to give then our calculation has been correct.

(To be continued.)

* For the first section of this article see The Electrical World of Nov. 18, 1893.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

(Compiled from the principal foreign electrical journals.)

BY CARL HERING.

ELECTRO-PHYSICS.

Electric Discharges.—"La Lum. Elec.," Nov. 11, reprints at some length from Wied. Ann., vol. 48, page 549, a paper by Messrs. Ebert and Wiedemann, on "Electric Discharges, Production of Electric Oscillations and Their Effects on Vacuum Tubes." They endeavor to give a basis for a qualitative and quantitative examination, from which can be deduced a large number of discharge phenomena in rarefied gases, without the necessity of admitting new properties of electrical movements. They start out with the principle that every discharge tube is a condenser, of which the armatures are the electrodes, and in which the gas takes the part of the dielectric, the walls of the tube being partly armatures and partly dielectrics. A description of the experiments is given, together with illustrations of the apparatus. In the continuation in the issue of Nov. 18 they discuss the general conditions for luminous excitation of tubes containing rarefied gases placed in electric fields, also the relations between the Lecher undulations and the constants of the circuits, including a number of tables.

Oscillations.—The Lond. "Elec. Rev.," Nov. 17, calls attention to a paper by Mr. Janet, in the August numebr of "Jour. de Physique," which it considers a valuable contribution; he concludes that in a condenser with solid dielectrics, under the influence of rapid electrical oscillations, there is a "lagging" of the charges behind the differences of potential; that is to say, for equal differences of potential the charges are smaller with increasing than with decreasing potentials.

Oscillations.—In "La Lum. Elec.," Nov. 18, Mr. Blondin begins a mathematical article on electric oscillations in cylindrical conductors; it appears to be taken, to a great extent, from a book by Prof. J. J. Thomson, on "Recent Researches in Electricity and Magnetism."

Electric Waves.—The Lond. "Elec. Rev.," Nov. 17, calls attention to a paper by Mr. Bjernkes, in the "Ann. der Phys. und Chem.," vol. 48, page 592, and Birkeland, in "Comptes Rendus," vol. 106, page 803; among other things, the former states his opinion that electrical waves represent the motion of molecules as a whole, while ordinary light waves are concerned with the motion of individual molecules.

Electric Waves.—The Lond. "Elec.," Nov. 17, reprints from the Italian an article by Mr. Mazzotto on the "Nodal Systems of Electric Waves as Obtained by Lecher's Method."

Maxwell's Electrical Theory.—The Lond. "Elec. Rev.," Nov. 17, calls attention to a paper on "A Modification of Maxwell's Electrical Theory," by Prof. McAulay in the August number of the "Phil. Mag."

The Solar System.—The "Bul. Soc. Int. des Elec.," for August-October, mentions a paper by Mr. Zenger, read before the French Association for the Advancement of Sciences, in which he calls attention to the zones of absorption in photographs of the sun and the atmospheric phenomena connected therewith, from which he is led to believe that the forces which govern the motions of the planets are of an electro-dynamic nature. He describes an experiment in which the vapors of hydrochloric acid and ammonia in a jar, from which the air is exhausted, are condensed by an electric discharge; the fumes commence to whirl around the axis of the discharge and the crystals deposit themselves in the direction of the lines of force; he states that by the action of the electric discharge on pulverized bodies one can produce the same phenomena which are visible on and around the solar disc; according to this author an electric discharge is the combination of two opposed whirling movements, and he endeavors to show that "it is the movement in space and not the undulatory movement, according to Hertz, which would characterize electric phenomena, and show the essential differences between light and electricity."

Resistances at Low Temperatures.—The Lond. "Elec. Rev.," Nov. 17, abstracts Dewar and Fleming's recent paper in the "Phil. Mag.," giving a large number of the tables (see Digest, Oct. 21).

Complex Quantities in Electricity.—Mr. Steinmetz's Congress paper is concluded in the "Elek. Zeit.," Nov. 17; in it he discusses the multiphase system.

Electrolytic Dissociation.—"La Lum. Elec.," Nov. 11, reprints from the Italian a paper by Mr. Carrara on the "Relations Between Electrolytic Dissociation and Rotary Optic Power."

Experiments with Balloons.—"La Lum. Elec.," Nov. 11, mentions briefly some recent experiments made in Germany for determining the electrification of air by means of balloons.

MAGNETISM.

Variation of Magnetism with Temperature.—Mr. Curie, in a note abstracted in the "Bul. Soc. Int. des Elec.," for August-October, finds that the coefficient of specific magnetization of oxygen at different temperatures is constant and independent of the intensity of the field and of the atmospheric pressure; the law of variation with the temperature is remarkably simple; between 20 degrees and 450 degrees C. the coefficient of the specific magnetization varies inversely with the temperature; this law readily enables one to establish a formula for correcting magnetic determinations made in the air at different temperatures.

Magnetic Susceptibility of Oxygen.—"La Lum. Elec.," Nov. 18, reprints in abstract from "Wied. Ann.," vol. 50, page 485, an article by Mr. Henning, in which he describes a method for comparing the susceptibility of different gases in magnetic fields by a direct measurement.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Standard of Light.—According to "La Lum. Elec.," Nov. 11, experiments are being made at the Physical Institute of Berlin, with the "Violle," or platinum unit of light, the intention being to keep the temperature of the platinum constant independently of its point of fusion; it has been found that at a given temperature the proportion of the total light to that transmitted by a layer of water of a certain thickness is always two per cent. for plates of platinum of various thicknesses. For measuring the quantities of light a very delicate bolometer has been constructed; experiments are being made with the absorption by the water and the quartz receptacle in which it is contained, also with the effects of impurities in the platinum.

Induction Coefficients.—"La Lum. Elec.," Nov. 18, reprints from "Comptes Rendus," Vol. 117, page 624, an article by Mr. Abraham, in which he describes a method of measurement in which the hundredth part can be measured with great ease and the thousandth part without much difficulty; it is based on the differential galvanometer, and appears to be quite simple, the only quantities to be known being the speed of revolution of a commutator and the value of a standard resistance.

Cheap and Simple Resistances.—In an illustrated article on "Industrial Rheostats," in "La Lum. Elec.," Nov. 18, Mr. Marcillac shows the great need of some simple, precise and reliable rheostat, which can be constructed cheaply; he shows several forms, one of which consists of a circular trough of rectangular cross-section filled with mercury, the continuity of which is broken in one place by an insulating plug, thus making it the equivalent of a rod of mercury; a movable crank pivoted at the centre of this circle contains a contact piece dipping into the mercury, the other contact being made at one end of the mercury column; by moving the crank more or less of the mercury may be put into the circuit; from the dimensions of the trough and the specific resistance of the mercury the values for every position of the crank can be readily calculated; for high resistance the mercury can be replaced by distilled water. In another form four long, straight, parallel mercury troughs are connected in series by a sliding bridge piece which can be moved lengthwise, thus varying the length of the mercury column from zero to the total length of the four columns in series. In another form an insulating tube is filled with lamp black, which is compressed by two copper plungers, which are secured permanently, and which serve as contacts; for utilizing portions of this, a number of pins or needles are run through the tube laterally, and lead out to contact pieces, thus enabling any fractional part of the resistance to be put into circuit.

Seismic Photochronograph.—The Lond. "Elec.," Nov. 17, in a note, mentions an apparatus described by Dr. Cancani in an Italian journal, for recording photographically the precise time at which an earthquake shock is felt; the apparatus is illuminated for an instant by an incandescent lamp thrown into circuit by any one of the seismic instruments; it has been in successful use at the Roccadi Pappa Observatory.

Condensers.—See also under "Oscillations."

Duncan Meter.—"La Lum. Elec.," Nov. 11, describes at some length, with the aid of 13 illustrations, the Duncan meter for alternating currents, the principle of which is analogous to that of non-synchronous single-phase alternating current motors, the starting being produced by a displacement of the field of the inductor; one of the chief claims for it is that it is cheap and not liable to get out of order.

Chamber of Delegates of the Recent Congress.—The "Elek. Zeit.," Nov. 10, page 651, reprints an address on the work of that body, by Dr. Budde, one of the German delegates; it may contain matters of interest, as there is no official record of the proceedings. Among other things, he states that there was apparently no preparation made for their work and that the discussions of societies and others, preceding the meeting of the Congress, were apparently ignored entirely.

Congress.—"La Lum. Elec.," Nov. 18, gives a short abstract of a recent address by Prof. Mascart, on the Chicago Congress and his impressions of America and the World's Fair.

DYNAMOS AND MOTORS.

Theory of Rotary Field Motors.—In "La Lum. Elec.," Nov. 18, Mr. Farman criticises briefly the recent article of Mr. Boucherot, published in that paper (see Digest Nov. 18 and 25); he explains the fact that different writers have obtained different results by stating that each has treated particular cases with different data, and not the general case; he shows that to treat the problem in a general way would be very difficult, while if certain considerations be omitted it becomes a very simple matter; he does not believe that the results obtained by Mr. Boucherot are conclusive, and he also criticises the theory of Hutin and Leblanc; he does not think that in the treatment of the problem the intensity of the field can be assumed as being constant, and that the field has a certain number of revolutions per second; on the contrary, he treats the subject by allowing for the variations of the flux, which give rise to secondary currents in the short-circuited windings of the armature, and it is the action of this current on the flux which determines the rotation of the armature; he calls attention to his recent paper which was mentioned in the Digest, Oct. 28.

Alternating Current Motors.—The "Bul. Soc. Int. des Elec.," for August-October, contains an article by Prof. Mascart on alternating current motors, in which he gives a very good summary of the mathematics and properties of such motors for both single and multiphase currents; the equations are mostly quite simple; it is probably one of the best general summaries which has been published.

Alternating Current Motors.—See also abstract of Forbes' paper for the transmission of power.

Alternators.—In his serial in the Lond. "Elec.," Nov. 17, "On Electric Motive Power," Mr. Snell discusses the effective values of alternating and direct currents, the equation for an alternator, and the different forms of the waves produced by different arrangements of the magnets and armature coils, which are illustrated by a series of cuts.

Details of Construction of Dynamos.—Mr. Richard continues his long, well illustrated serial in "La Lum. Elec.," Nov. 18; it appears to be taken mainly from patent specifications.

Fritsche Dynamo.—"La Lum. Elec.," Nov. 18, gives a short, illustrated description of this dynamo, taken apparently from patent specifications.

Application of Electric Motors.—"La Nature," Nov. 11, describes and illustrates a machine in operation in Paris, for reproducing statuary in stone from a model; the principle is the same as in carving machines of that kind, only that the drill is operated by an electric motor, it being connected directly to the end of its shaft, thus doing away with the complicated mechanical gearing to the movable drill.

TRANSFORMERS.

Rectifying Alternating Currents.—Mr. Pollak, in the Lond. "Elec. Rev.," Nov. 17, replies to two criticisms of his apparatus (see Digest Aug. 5, Nov. 4 and 25), and states that it is quite easy to keep the brushes in such a position that there is no sparking, but for motor purposes where frequent changes of load occur, an automatic arrangement of the brushes is provided. Regarding the use of his apparatus in alternating current stations, he says it permits of charging storage batteries with alternating currents during the times of small loads; it also enables alternating high tension currents to be used for railways by means of transformers and rectifiers. There is also a communication from him in the Lond. "Elec.," Nov. 17.

Ironclad Transformer.—The "Bul. Soc. Int. des Elec.," for August-October, reprints a note by Mr. Ruhmkorff from "Comptes Rendus," Oct. 9, 1871, in which he describes some interesting experiments; he was led to believe from certain experiments that if the iron circuits in his coils were closed he would obtain better results, but found that this was not the case; on cutting the core, which was formed of a ring, the length of the spark was double that before it was cut; by keeping the poles apart with a block of wood 5 millimetres thick, the length of the spark was increased sixfold over that before the circuit was cut; on increasing the distance between the magnetic poles still more the result was the same as before.

Transformers.—See also abstract of Forbes' paper under Transmission of Power.

ARC AND INCANDESCENT LIGHTS.

Candle Power of Search Lights.—The comments of Mr. Hospitalier mentioned in the Digest last week, are reprinted in the Lond. "Elec.," Nov. 17, in which it is also suggested that lighthouse lights had beter be ranked by means of a series of numbers as in a wire gauge.

Maximum Potential of the Arc.—The "Bul. Soc. Int. des Elec.," for August-October, mentions a recent paper read before the French Association for the Advancement of Sciences by Mr. Haton on the "Study of the Relative Maximum and Minimum Potential of the Arc."

Arc Lamps.—In Mr. Kennedy's serial in the Lond. "Elec. Rev.," Nov. 17, he discusses the friction brake or clutch regulators, the original invention of which he attributes to Messrs. Slater & Watson, in 1854; several of the modern forms are illustrated.

Incandescent Gas Lamp.—According to recent researches made in Berlin, this form of lamp cannot be used in places where there is considerable dust.

TRANSMISSION OF POWER.

Transmission of Power from Niagara Falls.—The Lond. "Elec." and "Elec. Eng.," Nov. 17, reprint the first portion of Prof. Forbes' paper on this subject, read before the Institution of Electrical Engineers (Prof. Forbes is

the consulting electrical engineer of that enterprise). In the introductory remarks he describes briefly the general arrangement for the utilization of the Falls. In the second portion he discusses the relative advantages of direct and alternating currents, deciding in favor of the latter; it was proposed by some to distribute direct current of about 800 volts within a radius of a mile or two, but if this plan had been adopted the surprising result would have been obtained that the cost to produce a horse power per annum at Niagara Falls would have been greater than at Buffalo, where the high pressure alternating current is to be used; the advantages of direct current for running motors loses much of its importance with the low frequency which he has adopted. Regarding the number of phases, he compares single-phase, two-phases and three-phases; he states that there are many motors suitable for single phase at low frequency which start without assistance, he claims to have seen them at work in many workshops, nearly all of which seem to work very well and promise to be very efficient at low frequency; for heavy work which continues without stopping, he believes that no motor can be more suitable than the synchronizing single-phase alternator; he claims that even if single-phase motors are to be adopted it is better for the generator to have two phases, as the output per size and cost is greater, and the rectification of the current for street railways, electrometallurgy, etc., is easier; multiphase motors are already in use largely, and even in small sizes have a very good efficiency. He claims that some of the alleged advantages of three over two phases cannot be supported, as, for instance, the claim that there is a saving of copper in the lines of 25 per cent. over one-phase and 25 per cent. or 13 per cent. over two-phase systems, according as four or three wires are used, he claims that the three-phase system has not this advantage; furthermore, the statement that any pair of the three wires in a three-phase system may be used for a distribution for lighting, is not the case, a two-phase system of two completely independent circuits is much more suitable; he says that it is not confirmed by practice that there is a smoother starting and rotating effort with the three-phase than with the two-phase system; he then points out the objections against the three-phase system: it introduces trouble in maintaining the efficient working of the line and in testing it; when the three circuits are unequally loaded the voltage varies considerably, which he shows by giving tabulated results of an experimental examination; to obviate this it has been proposed by the Oerlikon Company to use only one circuit for lighting and maintain this at constant voltage, and use the three circuits together only for power purposes, but this was not considered satisfactory for the plant at Niagara Falls. He then discusses at some length the very important subject of the frequency and decides in favor of the very low frequency of 16⅔; it is a matter of common knowledge that parallel working is assisted by lowering the frequency; although with lower frequency the transformers must be increased in size, the increased cost is not in proportion to the lowering of the frequency because a higher induction can be used; according to Mr. Steinmetz, the loss due to hysteresis varies as the 1.6th power of the induction and it is this loss which must be kept constant when the frequency is varied; from this he deduces the fact that for a constant hysteresis loss in any transformer its power of doing work varies in proportion to the frequency raised to the 0.4th power, although the induction should not be so great as to saturate the iron; therefore, by doubling the frequency the same transformer will yield 132 units instead of 100, and by quadrupling it, it will give 174; he says that this result was also obtained by Stanley and others empirically; if the frequency is reduced one-half the cost is increased about 50 per cent. and he is thoroughly convinced that the gain is far in excess of this amount. As regards motors, he believes that there is a gain of at least three per cent. in their efficiency in 21 periods over 42 periods, which increase of power capitalized at five per cent. and at the rate of $10 per horse power, represents an increased value of $6 per horse power for the plant, against which there is an increased cost of transformers of only $1.76; he thus concludes that it is quite certain, from a purely economical consideration, that a frequency lower than any which has heretofore been adopted is advantageous; after discussing the speeds of the dynamos and motors, he determines on 16⅔ periods as the frequency which will be the most favorable at this plant so far as motive power is concerned. Another indirect advantage of this low frequency lies in the fact that ordinary continuous current dynamos of any size may be used as synchronizing motors by means of rings attached to the commutator bars; but the greatest advantage is in the improved efficiency of the motors; in a certain case he found that by lowering the frequency from 56 to 41, the output was increased 15 per cent. and the efficiency three per cent.; in every self-starting alternating current motor the starting effort is increased by lowering the frequency; the ordinary direct current motor with a laminated field works extremely well with low frequency; from what he has seen in the workshops of electricians he is confident that before long single-phase alternating current motors, self-starting at full load, will be used largely. Commutating devices are also better at low frequency than at high; he also believes that perhaps the greatest advantage of low frequency is in connection with the line, and in parts requiring high insulation; there will also be less trouble with the capacity of cables, and the serious troubles which have been encountered at Deptford and elsewhere in the abnormal rise in the voltage can be reduced as much as one pleases by lowering the frequency; furthermore any induction in neighboring telephone circuits is utterly inappreciable at such a low frequency; regarding the disadvantages, he mentions that such a low frequency is not suitable for direct electric lighting, but he believes that this is of little importance in this plant, as it is decidedly preferable to convert the current. The paper is to be continued.

In a long editorial discussion of this paper in the Lond. "Elec. Rev.," Nov. 17, it is thought that the pressure curve of the dynamos will not even approach the sine curve, and that a steady voltage will be generated for a considerable time at the maximum, and such a curve in the primary circuit will produce a very bad form of secondary current in the transformer and is not good for two-phase or multiphase motors; it is also thought that the dynamos would vibrate considerably when running loaded. In this editorial it is stated that a frequency of 25 has been adopted, while in the paper, as far as published, it appears to be 16⅔; belief is expressed that the chief trouble with the motors will arise on the patent question, and that the introduction of the two-phase system will be hampered by patent litigation. The Lond. "Elec.," in a short editorial note, claims that the expedient to improve the efficiency of the motors by using low frequency is a confession of weakness in design.

Transmission of Power.—Prof. Unwin's fourth lecture is concluded and the fifth lecture begun in the Lond. "Elec. Eng.," Nov. 17; the subject of the fifth lecture is "Transmission by Compressed Air."

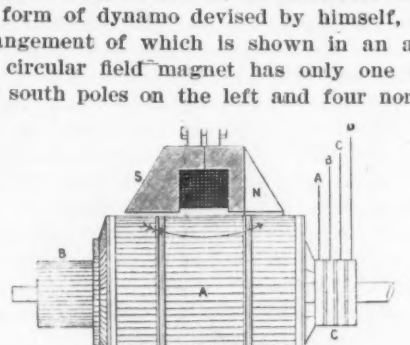
ELECTRIC RAILWAYS.

Horse and Electric Traction.—The "Elek. Rundschau," No. 4, abstracts briefly an article describing a recent test made, in which the cost of traction for horses was .037 cent per car kilometre, and .022 cent for electric traction, the saving representing 18.5 per cent. of the total cost of traction.

Gearing.—The article on motor gearing for railways is concluded in the Lond. "Elec. Eng.," Nov. 17, in which worm gearing and bevel spur wheels are discussed.

CENTRAL STATIONS PLANTS, SYSTEMS AND APPLIANCES

Two-Phase System.—In Mr. Kennedy's serial in the Lond. "Elec. Rev.," Nov. 17, he describes and illustrates a form of dynamo devised by himself, the general arrangement of which is shown in an adjoining cut; the circular field magnet has only one coil, but has four south poles on the left and four north poles



Kennedy Two-Phase Dynamo.

on the right, which are staggered, thus forming the equivalent of an eight-pole generator; the field magnets are made of two castings, and the armature is drum-wound in the form of a multipolar series wave or loop with end connections; the framework of the armature consists of a broad rimmed cast steel pulley, on the outer periphery of which are thin rings of sheet iron forming a laminated surface next the poles, the laminations being perpendicular to the axis; the magnetic flows is (in part) parallel with the axis, in which respect it differs from other drum armatures; an elevation and a perspective view are also given; the advantages claimed are the exceedingly simple design and the very cheap cost of manufacture; he also claims an enormous output from an apparently small amount of material; continuous currents may be taken from the collector at the ends for excitation or for other purposes; he claims that the magnetism through the rim of the pulley has a steady flow, and therefore sets up no eddy currents; also, that the disturbing effects of the armature currents on the field are reduced to a very small amount. He also describes and illustrates a Schuckert eight-pole machine. Regarding frequencies, he states that experience has convinced him that the frequency of quadrature currents must not be less than from 60 to 64.

Polyphase Currents.—The Lond. "Elec. Eng.," Nov. 17, reprints in abstract an article by Mr. Shasseloup-Laubat from the transactions of a French civil engineering society, in which he discusses the comparison between distribution by continuous and alternating currents; various arrangements are discussed, and a number of systems of using accumulators are described and illustrated, without, however, giving anything apparently new. One of the recent apparatus of Hutin and Leblanc is spoken of favorably.

Three-Phase Machinery.—The "Elek. Rundschau," No. 4, continues its illustrated description of the Siemens & Halske apparatus.

Alternating Current System.—See also abstract of Forbes' paper under Transmission of Power.

Low Frequencies.—See also abstract of Forbes' paper under Transmission of Power.

Alternators in Parallel.—The article by Mr. Stanet (see Digest, Nov. 4) is concluded in "L'Elec.," Nov. 11; he discusses the coupling of any number of alternators in parallel, and finds that the favorable conditions of stability are exactly the same as in the case of two alternators; namely, a small self-induction in the external circuit, a small internal resistance of the alternators, and a coefficient of self-induction of the alternators as given in the first part of his article.

Regulation of Continuous Current Motors.—Mr. Leroy, in "L'Elec.," Nov. 11, describes and illustrates a starting device, in which the motor current is passed through a contact of two carbon rods held like in an arc lamp, the upper one of which is raised by the action of a solenoid, through which the motor current passes; on starting the motor an arc is automatically formed between the carbon points, which gradually diminishes as the motor comes up to speed, being extinguished entirely when the motor has attained its proper speed. Another device is described, in which a magnetic clutch connects the armature shaft with the driving shaft, the clutch being operated by a coil connected to the two brushes; when the motor is at rest or starting, most of the current goes through the armature, the clutch being open, but as the voltage of the armature increases more current goes through the clutch, until at full speed the clutch couples the motor shaft to the driving shaft (as it consumes current continually and requires a separate driving shaft, it hardly seems as good as other devices).

Polarity Test for Central Stations.—In the Lond. "Elec. Eng.," Nov. 17, Mr. Horne describes briefly a device used in connection with shunt dynamos when connected in parallel to bus bars; the terminals of the starting-up voltmeter are connected to the bus bars, each through an incandescent lamp; the terminals are likewise connected to the dynamo whose polarity is to be determined; when the machine is not excited, the lamps will both glow with half the voltage of the circuit (their circuit being closed through the armature), and if, after the dynamo is excited, it has the right polarity, the lamps will be extinguished; but if the polarity is wrong, they will burn with their full voltage.

Snap Switch.—The "Elek. Echo," Nov. 11, publishes as a supplement a number of illustrations of a snap switch, which is said to have originated with the firm of Siemens & Halske.

Central Stations in Germany.—In an address by Dr. v. Stephan, reprinted in the "Elek. Zeit.," Nov. 10, the following statistics are given for July of the present year; they include the German Empire, with the exception of Bavaria and Wurtemberg. There are 4,974 installations, of which 4,884 are for electric lighting; the number of incandescent lamps is 852,263; the number of arc lamps is 44,588; of the remaining 90 installations, 22 are for electrolytic purposes and 68 for power transmision; 328 use alternating currents, 148 direct and alternating currents, 5 three-phase currents, and 4,493 direct currents; in 131 the lines are underground, and in the others they are mostly overhead; uninsulated wire is used in 2,370 of them.

Central Stations.—London "Lightning" publishes every week a table of itemized costs per unit delivered to customers, of supplying electricity from central stations in the United Kingdom.

Erding.—London "Electricity," Nov. 10, gives a well illustrated description of the three-phase station in this town, which was already mentioned in the Digest, Oct. 28.

Paddington.—London "Electricity," Sept. 29, just received, contains an illustrated description of the Amberley road station, Paddington, including a large interior view and elevation.

Kensington Station.—The Lond. "Elec. Rev." and Lond. "Elec. Eng.," Nov. 17, publish the second and last portion of the committee report on this station.

Gablonz.—The Lond. "Elec.," Nov. 17, gives a brief description of this station (see Digest, Nov. 25).

Advantages of Gas Engines.—The "Bul. Soc. Int. des Elec.," for August-October, states that, according to Mr. Bouquin, one cubic metre of gas gives 91 candle hours in a Bengel burner, 162 in a candle power incandescent lamp, 200 in a Wenham lamp, and 654 in an arc lamp.

Station Management.—"Lightning," Nov. 9, publishes a series of rules for the guidance of electricians in charge, engine drivers, stokers, cleaners and electricians on mains.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Protection of Telegraph Installations.—In a paper by Dr. Strecker, reprinted in the "Elek Zeit.," Nov. 17, he discusses at some length the injury done to telegraph instruments and people by electric lighting and power

circuits; after discussing a large number of devices, which are not satisfactory, he describes the following, which is satisfactory in every respect except that it is much too expensive; the magnetic coils of the Morse apparatus are surrounded by tubes of brass, which have been cut, a small piece of readily fusible metal, such as the Wood metal, is bridged over the cut, and designed to melt at 70 to 100 degrees C. by the heat developed in the coil, a spring stretched across this fusible metal is thereby released, and the circuit broken, which takes about eight minutes.

Telephone and Electric Lighting Currents.—The lengthy discussion on this subject is continued in the "Elek. Zeit.," Nov. 17, by an article by Mr. Uppenborn, and another by Mr. Erhard, the latter describing at some length the effect of a three-wire system in Altona.

Telegraph in High Altitudes.—The Lond. "Elec. Rev.," Nov. 17, describes briefly what is probably the highest elevated telegraph line in the world, it being about 15,000 feet above the sea, crossing the Himalayas at Jelapla.

Telegraph and Telephone Statistics for Germany.—Comparative statistics for this and last year are given in the "Elek. Zeit.," Nov. 10, page 651.

ELECTRO-CHEMISTRY.

Internal Resistance of Accumulators.—The serial of Mr. Streintz in the "Zeit. fuer Elec.," on the theory of accumulators, is continued in the issue of Nov. 1; he describes, with the aid of a diagram, a somewhat complicated but interesting method of measuring the internal resistance of accumulators, and gives the results of measurements made for different currents; these show some facts that may not generally be known; the internal resistance was found to be a function of the current; for small currents it is greater than on open circuit, while for stronger currents it again falls and becomes lower than on open circuit (the compiler has been told of another case in which the same result was found by another observer); the internal resistance on open circuit increases also with the number of discharges of the accumulator.

Tommasi Accumulators.—"La Lum. Elec.," Nov. 11, gives at some length a description of this cell, with illustrations, as also a description of the train-lighting installation on a French railroad, in which 50 cars are being equipped with this battery; the latter installation has already been referred to in these columns. The accumulator, called "multitubular" (although there is an entire absence of even a single tube), consists simply of a very open grid surrounded by active material, the whole being then surrounded by a perforated envelope of celluloid; in this way great lightness is undoubtedly obtained; the other claims are those usually made for a new accumulator. Figures are given showing that 20 to 25 ampere-hours per pound of lead (but not per pound of plate) is obtained at double the discharging rate of other accumulators; it is stated that 12 cells, weighing 230 kilograms, have a capacity of 5,600 watt-hours, or about 32 kilograms (70 lbs.) per horse-power hour; in a table of comparative figures it is stated that from 400 to 500 kilograms of battery of the other systems would be required for propelling a carriage for four persons with a mean of about 1 h. p. (The accumulator resembles the original Faure cells in which the felt is replaced by perforated celluloid and the lead conductor is perforated.)

Henzel Accumulator.—"La Elec.," Nov. 18, describes briefly and illustrates the plates of this accumulator, which are made entirely of minium mixed with sulphuric acid and a small amount of silicate of soda and gelatine; they are compressed and dried in a mold at high pressure, after which they are covered with a coating of silicate of soda and gelatine in the proportion of 4 to 1.

Lalande and Chaperon Cell.—The "Elek. Anz.," Nov. 16, describes and illustrates this cell, as recently improved in France. The electrodes are all made in the form of parallel plates, like an accumulator; the positive plate is made of a box-shaped frame of tinned or copper plated iron, in which are held the plates of compressed copper oxide; the latter may be readily removed by opening this frame, the parts of which are held together by a simple mechanical device; the copper oxides are made by mixing four to five per cent. of clay with the scales obtained in forging copper, and compressing the mass under hydraulic pressure in a suitable mold, after which it is heated up to about 700 degrees C.; in another method six to eight per cent. of asphalt is used in place of the clay, and the plate is afterward heated to redness. The equation of the reaction is given, as also the results of some recent tests; three forms of this cell are illustrated.

Iron Plating.—"La Lum. Elec.," Nov. 11, gives the following formulas for a bath for plating copper and zinc plates used for printing, with a layer of iron; when not so plated, only about 1,500 to 2,000 impressions can be taken from such a plate, while the covering of iron makes them almost like steel. The bath consists of 400 grammes of water, 400 of hydrochloric acid, 100 of iron, 100 salammoniac, and 25 of glycerine; the iron is dissolved in the acid and is then mixed with the water in which the salammoniac has first been dissolved, the glycerine being added for preserving the bath; carbonate of ammonia can be used instead of the chloride; the plate is first left in the bath for only a few minutes, then removed and brushed with fine emery and water, then washed and again placed in the bath, this operation being repeated four or five times until the deposit is sufficient; two other receipts are also given.

Sugar Refining.—The Lond. "Elec.," Nov. 17, mentions a note by Lippmann from the "Engineer" on the purification of beet root juice; the warm diffusion juice was subjected to a current of 30 to 40 amperes from four to five volts between electrodes of zinc, which precipitates a thick, muddy substance at the anode; the current coagulates the albumen, which carries down many other substances, while the zinc oxide also combines with numerous organic substances; the juice remains quite free from zinc; doubt is expressed whether the excellent purity of the sugar made in this factory is due to the effect of electricity, or whether a judicious coagulation of albumen before purification would not lead to equally good results.

Separation of Metals.—The Lond. "Elec. Rev.," Nov. 17, calls attention to an article by Mr. Freudenberg in the "Berichte," vol. 25, p. 2,492, in which he considers the separation of metals by a regulation of the voltage as a new principle.

Electrolytic Reduction of Nitro-Benzine.—"La Lum. Elec.," Nov. 11, describes briefly the Noyes process.

Constitution of Electrolytes.—"La Lum. Elec.," Nov. 18, reprints a translation of a portion of a book by Mr. Ostwald, on "Chemistry and Physics."

Electrosynthesis.—The Lond. "Elec. Rev.," Nov. 17, contains a short article on this subject from the "American Chemical Journal," vol. 15, No. 6.

MISCELLANEOUS.

Fire Damp Indicator.—In "La Lum. Elec.," Nov. 18, Mr. Lalande describes what appears to be a simple and effective device for indicating the presence of fire-damp; finely divided platinum black mixed with a small quantity of asbestos is placed on a small shelf, through which passes a cord made of gun-cotton, holding back a spring contact, which, on being released, closes an electric circuit for ringing an alarm bell; the whole is inclosed by a perforated metallic screen as in a miner's lamp; when the amount of fire-damp becomes sufficiently great the platinum black, according to well known principles, becomes heated, sets fire to the gun-cotton, which in turn releases the strong contact and closes the circuit; both the platinum black and gun-cotton retain their properties without alteration for long periods, thus making the apparatus very reliable; several illustrations are given.

The New Method of Heating Metals.—The "Elek. Zeit.," Nov. 10, p. 652, contains some further information by Dr. Epstein on the Lagrange and Hoho process (see Digest, Nov. 11). Among other things he states that the voltage must be smaller the smaller the electrode; the heat may also be produced at the positive instead of at the negative pole; with alternating currents the heat is always produced at the smaller electrode; for direct currents the relative sizes of the negative and positive electrodes are more important than the absolute size of the negative; if the negative is surrounded by a test tube with a small hole in it the phenomenon of heat generation may be produced either at the electrode or in the hole, depending on the depth of the immersion.

Treatment of Cancer.—The Lond. "Elec. Eng.," Nov. 17, mentions a recent article in the "Lancet" by Dr. Inglis-Parsons, in which he describes an electric treatment of cancer, in which two needles are employed with a current of 200 to 400 milliamperes, the caustic action of both poles being used freely and the current being constantly reversed in direction.

Death from High Tension Currents.—The "Elek. Echo," Nov. 4, reviews a French work by Dr. Frances Briaud, in which he summarizes the literature of the subject and makes some deductions; among the questions which he discusses is whether death results from the high voltage or from the current, also whether the electricity causes a stoppage of the action of the lungs or the heart, or produces a change in the blood corpuscles, or whether it has a reflex action on the brain; he states that the physiological action of alternating currents, according to a number of authorities, increases up to 3,000 alternations per second, but then decreases, and at 10,000 alternations or action is no longer felt. The Lond. "Elec. Rev.," Nov. 17, gives the first part of quite a thorough review of this book.

Electric Furnace.—The Lond. "Elec. Eng.," Nov. 17, abstracts an article from "Comptes Rendus," by Mr. Moissan, in which he describes the fusion and volatilization of metals and oxides.

Recent Progress.—The "Elek. Zeit.," Nov. 10, reprints in full the address of Dr. Stephan before the opening meeting of the German Electrical Society, giving a review of recent events and progress; it appears to be limited almost entirely to Germany, and contains some statistics on electric lighting and power stations, as also on telegraphy and telephony, the former are given in abstract in these columns under the heading, "Central Stations."

Application of Electricity in the Industries.—The "Bul. Soc. Int. des Elec.," for August-October, mentions a recent paper by Mr. Janet, read before the French Association for the Advancement of the Sciences, in which he gives a resume of the subject, without, however, giving anything new.

Fishing with Electric Light.—According to "La Lum. Elec.," Nov. 11, experiments are being made in the Mediterranean, in which porpoises are attracted by means of the electric light, and after being surrounded by a net are killed by exploding dynamite in the water; in a recent experiment, every one of those in the net was killed, and the method is said to have been very satisfactory.

Educational.—The Lond. "Elec.," Nov. 17, reprints the presidential address of Mr. Bary before the Junior Engineering Society on the education of an engineer, referring, however, more to civil engineering.

Educational.—Mr. Waterhouse, in the Lond. "Elec. Rev.," Nov. 17, discusses the subject of electrical education in a brief communication.

Biographical.—The London journals of Nov. 17 announce the death of Mr. Anthony Reckenzaun, and give short biographical notices.

Storage Batteries for Central Stations.*

BY C. O. MAILLOUX.

Since the report was read at Milwaukee, the writer has discovered therein a mistake, which is partly accounted for, if not altogether excused, by the limited time in which it was prepared, it having been, in fact, mostly written on the way to Milwaukee, owing to the delay experienced in receiving the data requisite, from various sources.

By an error in pointing off decimals, the cost of a 1,300 kw. hour battery was wrongly given as $8,450 instead of $84,500. The saving figured out in that case, of course, vanishes with the change, were it not for further corrections, which can now properly be made and which partly compensate this error. The abstracts of the paper, published by the technical press, have had the effect of waking up American battery manufacturers to a realizing sense of the importance of the results obtained in Europe, and of the necessity of their making efforts to prevent the European manufacturers from invading the field in this country. No less than three concerns have already informed the writer of their intention to immediately put large central station batteries on the market. In one case the writer was shown the plates in process of manufacture. The information obtained by the writer since the paper was read seems to show quite conclusively:

1. That the cost of large central station batteries will not exceed $35 per kilowatt hour, set up, in most cases, and for smaller sizes will not exceed $50 per kilowatt hour.

2. That the cost of maintenance will not exceed 10 per cent. of the initial cost.

3. That the rate factor can be safely based on three hour discharge, or even less, in most cases, instead of four hour discharge as assumed in the paper.

If we make use of these amended data, we find that not only the cost per unit of battery capacity, but the total capacity itself, can be reduced. In the case considered, the required capacity now becomes reduced to that determined by the quantity factor, instead of being determined by the rate factor (43 per cent. more); hence a battery of 910 kw. hours capacity will be enough. This at $35 will cost $31,850. The interest (6 per cent.) and the maintenance (10 per cent.) will make the annual cost $5,096. This is equivalent (for 365 days) to $13.96 per day. As the coal saved, in this case, was calculated to be 4.47 tons, it follows that the use of the storage battery would only pay if coal cost over $3.15 per ton, instead of $1.10 as given in the paper.

*An appendix to a report on this subject read at the Twelfth Annual Meeting of the American Street Railway Association, Oct. 18, 19 and 20, 1893, and abstracted in THE ELECTRICAL WORLD of Oct. 28, 1893.

The Hydrocarbon Suit.

The United States Circuit Court of Appeals for the Third Circuit has dismissed the appeal of the United States Electric Lighting Company against the Edison company in what is known as the hydrocarbon suit, sustaining the claim that the Weston patent is void on account of prior use and publication by Sawyer and Man. The history of this case is interesting, as it was depended upon to shut off all except the owners of the Weston patent from using a process which had otherwise been employed under the conviction that it had fallen into public domain. In 1849 Depretz, a French savant, noted and described in the "Chemist" that when he heated a carbon rod by electricity in a hydrocarbon gas there occurred a deposit of hard carbon, which rendered the rod homogeneous, and gave it a hard, smooth, solid surface, while increasing its diameter. In 1870 Sidot presented to the Academie des Sciences a report of his experiments in producing by electrical deposition dense, hard carbons which suggested their adaptability to electric lighting purposes. Several patents were taken out by Maxim and Edison, more or less involving the deposition of carbon from an atmosphere of hydrocarbon gases, and these were in-

troduced by the defendants as part of their case. As early as 1878 Sawyer and Man, more than three years before the application for the patent in suit, treated the carbon rods of incandescent lamps, which they were making experimentally, by electricity, heating them in both hydrocarbon gases and hydrocarbon oils, and used the carbons so treated in these incandescent lamps, and this process was continuously used by them from that time on, although they did not succeed in making commercial lamps, because of their failure to employ a filament in a sufficiently high and stable vacuum. The process of treating the carbons was described and patented by Sawyer and Man in patent No. 211,262, July 7, 1879; and, as much as a year before, both lamps and process were publicly exhibited and described in contemporary publications.

This hydrocarbon process is one of the most beautiful known to the electric art. By its means a carbon filament of uneven resistance, and which when brought to incandescence would be brighter in some spots than in others, is rendered of uniform resistance and brilliancy. The process is now carried on automatically, the carbon filaments in the gas being brought to a white heat by the current, and each one cut out as soon as the point of uniform resistance is reached. It is an exquisite example of nature doing her own beautiful work.

It was shown that Weston's efforts to claim priority of invention could not be sustained, and that the date of his first application, May 27, 1881, and of the patent, Oct. 21, 1884, and the incorporation in both of knowledge which Sawyer and Man had made public as long as three years previously, precluded the possibility of his being the first inventor.

Electric Heating for Street Cars.

BY EDW. B. WYMAN.

"There is a certain attraction in the burning of coal which gives a quiet sense of satisfaction to the passenger."

The above quotation is taken from a paper written by Mr. G. F. Greenwood, on "The Best Method of Heating and Lighting Street Railway Cars," which was read at the twelfth annual convention of the American Street Railway Association, at Milwaukee, Wis., Oct. 19, 1893.

How pleasant it is to enter a street car in winter all bundled up in a heavy overcoat and fur cap and be obliged to take a seat beside a coal stove and enjoy its pleasant heat and the fumes of noxious gases; or to sit at either end of the car and fancy yourself sitting on an iceberg, and still enjoying the noxious gases! This is a "quiet sense of satisfaction" and has a "certain attraction" for the passengers on street railway cars, in the opinion of Mr. Greenwood; but ask the majority of patrons of street railway cars if they have this "quiet sense of satisfaction" feeling, and I think they will say decidedly no!

This is an age of electrical progress. Electricity has superseded horse and mule as a method for propulsion of street railway cars. So it has superseded the stove as a method of heating.

In Mr. Greenwood's letter all of the many good points in favor of electric heaters for street cars are overlooked or not mentioned; but if these are considered by any reasonable manager of electric street railway lines he would immediately decide to adopt them for his cars. The question of economy in the use of electric heaters on street cars has been gone over many and many a time. On reading Mr. Greenwood's paper it will be noticed that the only objection he makes to electric heaters is that their cost of operation is greater than that of stoves. So is the cost of electric light greater than gas, candles or kerosene. Yet electric light is used and preferred. Mr. Greenwood holds that the expense of operating electric heaters is three or four times greater than that of coal stoves. This is an exaggeration. He places the cost of current at nine-tenths of one cent per kw. hour. Is it not produced for seven-tenths of one cent per kw. hour? Mr. Greenwood admits that the cost of operating electric heaters is variable, costing from 32 cents to 81 cents per day. For coal stoves he gives a steady cost of 15½ cents per day, regardless of weather. Does this mean that the heat from the stoves is steady, instead of being regulated to the actual needs? and that stove heating is not practicable for slight cold spells?

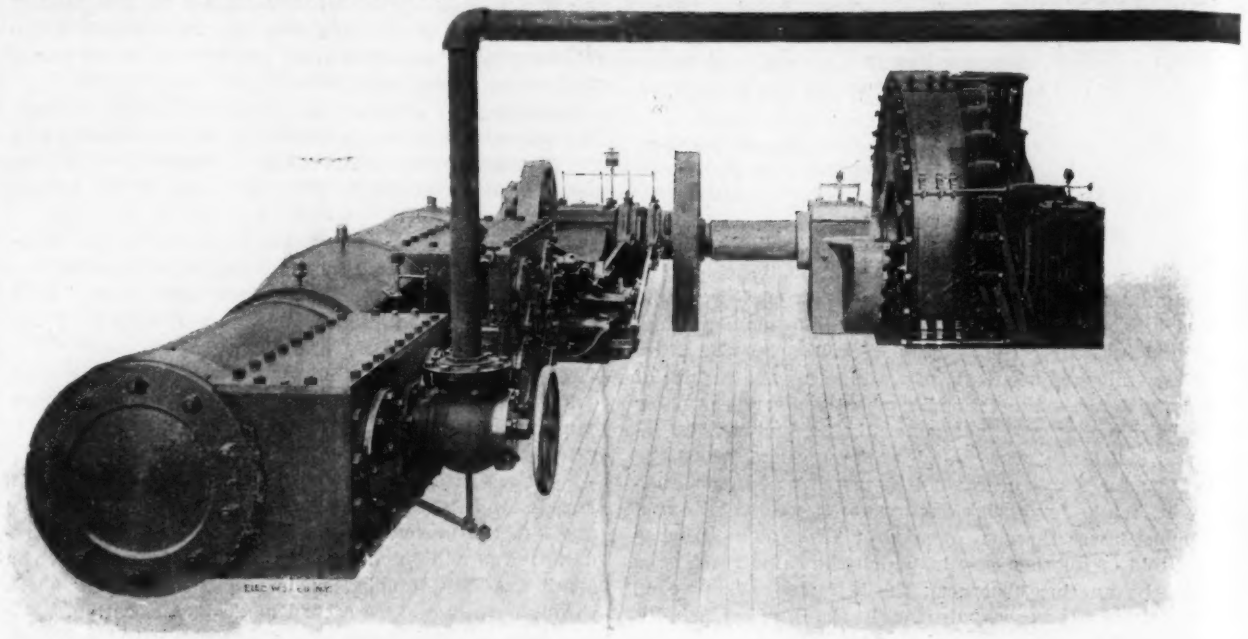
From my investigations I think that the average cost of operating electric heaters on street cars will not exceed 25 cents per car day or nine cents more than coal stoves. This seems a very small extra expense when one takes into consideration that valuable passenger space in the car is saved, cleanliness retained, no noxious gases produced, an even distribution of heat and the comfort of patrons obtained. The car is not warped out of shape nor is its roof burned, nor its interior decorations covered with smoke and soot. Electric heaters are always ready when required, and when not required may be instantaneously cut off and thus expense for heat ceases. I think the average manager of street railways, when he stops to consider both sides of the question, will say at once that the many good points in favor of electric heaters for street cars will more than compensate for their slight extra expense in operation.

When electric heaters become generally adopted by street railway companies there will be "a certain attraction" in their cars, and their patrons will enjoy that "quiet sense of satisfaction."

Exhibit of the Buckeye Engine at Milwaukee.

One of the notable exhibits at the recent Milwaukee Street Railway Convention was that made by the Siemens-Halske Electric Company of their direct-driven generator for the power station at Cincinnati, O. The engine, being an integral part of the display, excited particular interest. A good view of this exhibit is given herewith.

The engine was built by the Buckeye Engine Company, of Salem, O., and was a good model of the machines manufactured by that well known firm. It is known as the tandem compound engine. The high



DIRECT CONNECTED BUCKEYE ENGINE AND DYNAMO AT MILWAUKEE.

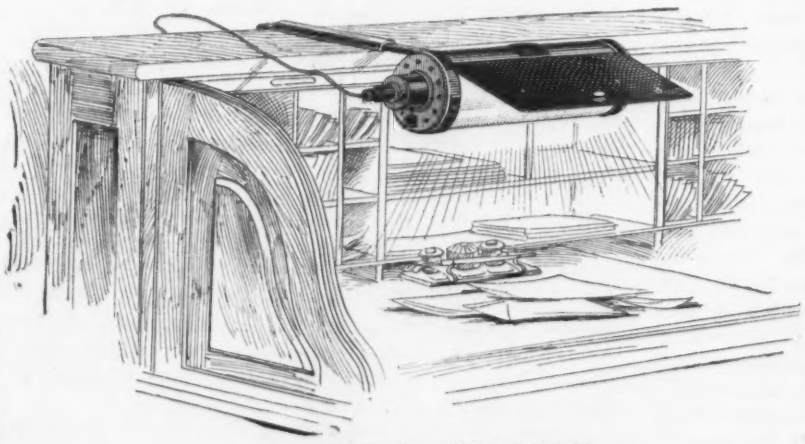
pressure cylinder is 20 inches, the low pressure 32½ inches, and the stroke 36 inches. Steam was supplied from the Exposition Building through temporary piping, and the engine kept in operation during the three days of the convention.

An interesting feature of the display was the work required in its installation. The total weight being 80 tons, it was impossible to find a suitable location in the Exposition hall, so a temporary foundation was prepared just outside the building. The foundation was made of 6 by 6 and 12 by 12 timbers, and pits were dug for the engine and generator flywheel.

An Adjustable Desk Light.

The great adaptability of the incandescent lamp for purposes where it is desirable to control the intensity and arrange the light in the most convenient position for use is shown in a striking manner by the Kinsman desk light, recently placed on the market by McLeod, Ward & Co., 91 Liberty street, New York.

An ordinary 16 or 32 c. p. lamp is inclosed within a handsome nickel-plated cylindrical case, which, by means of a clamp, can be firmly secured to any desk without marring it or interfering with the use of the top. To change the light to another desk it is only necessary to loosen the thumb screw of the clamp, when the fixture is at once released.



A CONVENIENT DESK LIGHT.

The lamp is inclosed by a glass cylinder, which turns in the case; one-third of the circumferential surface of the cylinder is ground, another third is tinted green and the remaining third is clear; so that by turning it the full intensity of the light may be had, or a softened or green light when one of the other surfaces of the cylinder is at the opening in the case.

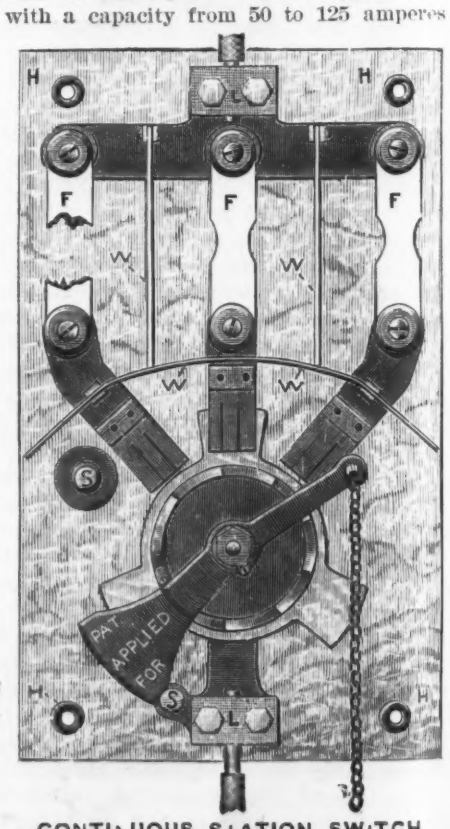
In order to adjust the light at the most convenient point the case can be moved in or out, the flat rod supporting it telescoping in the clamping arrangement. A reflector is also so secured to the case as to be adjustable, thus not only enabling the light to be kept from the eyes but permitting it to be more or less concentrated on the surface beneath.

A Continuous Station Switch.

A very convenient device for central station equipment, and especially for alternating circuits, has recently been designed by C. E. Jones, of the Jones Brothers Electric Company, Cincinnati, O., the idea of the designer being to provide for sufficient safety devices to insure the continuous operation of circuits.

What may be called a three-point switch is provided with a ratchet inner circle into the cogs of which an operating lever meshes. The lever is provided with a chain at one end and a counter weight at the other, so that it is practically automatic in operation. Pivoted to the centre is the binding post of one contact and the upper part of the device supplies the other contact point of the circuit. In the three insulated sections shown in the illustration are arranged safety fuses of whatever capacity the circuit requires. The safety fuses are insulated from each other by a fibre wall, so that there is no danger of a flash across.

The switch operates as follows: If, for illustration, the fuse section No. 1, shown in cut as having been ruptured, is blown by short circuit or otherwise, the attendant immediately pulls the lever and the lower contact is thrown in circuit with the second safety fuse. It is the position the cut shows. Should a second short circuit occur, the switch is pulled around to the third safety fuse. In the meantime new fuses are inserted in Nos. 1 and 2 ready for another emergency. The base of the switch is of marble, the separating walls of fibre and the metal parts of pure copper. One size is made with a capacity from 50 to 125 amperes



CONTINUOUS STATION SWITCH.

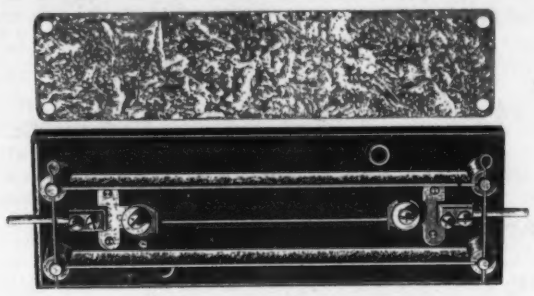
for either direct or alternating current, and another with a capacity of from 125 to 150 amperes.

Several of these devices have been in operation in the central station at Cincinnati, and their performance has been most satisfactory, so much so that all circuits leading out from the station are now being equipped. Other stations in different parts of the country have also adopted them.

Improved Fuse Box.

We illustrate a covered fuse box for use on 500-volt circuits, recently perfected and placed on the market by the W. S. Hill Electric Company, of Boston, Mass. The

metal terminal blocks are mounted on a slate base, and the parts are all protected by a box made of mica, the removable cover of which is held in place with two



IMPROVED FUSE BOX.

wire pins, so as to be readily removed to permit of replacing a blown fuse. The box is light and compact, as well as neat in apearance.

NEW BOOKS.

DRUM ARMATURES AND COMMUTATORS. THEORY AND PRACTICE. A Complete Treatise on the Theory and Construction of Drum Armatures, and of Commutators for Closed-Coil Armatures. Together with a Full Résumé of Some of the Principal Points Involved in Their Design: and an Exposition of Armature Reactions and Sparking. By F. Marten Weymouth. London: The Electrician Printing and Publishing Company. 1893. 294 pages, 162 illustrations. Price $3.00.

This book is made up of articles, revised and enlarged, that originally appeared in the London "Electrician," and is intended as a useful guide or introduction to those who may wish ultimately to proceed to the mathematical treatment of the subjects considered, and mathematics consequently are almost entirely avoided.

The first chapter is on the generation of potential in drum windings, and the following eight chapters describe in detail numerous systems of drum windings. The next four chapters are on commutators and their construction and the remainder of the volume, with the exception of one chapter on the taper of commutators, is devoted to sparking at commutators—13 chapters in all being on this subject, which is treated in all of its bearings. These chapters take up in turn the elementary theory of sparking as caused by self-induction, displacement of brushes, short circuits, etc, and the effect of armature defects and reactions, the latter being considered in great detail.

While the engravings are poor and the writer exceedingly verbose, yet the book contains a collection of information on the subjects treated that cannot be found elsewhere in detail, and therefore has a wide field of usefulness.

DISCUSSION OF THE PRECISION OF MEASUREMENTS. By Silas W. Holman, Associate Professor of Physics, Massachusetts Institute of Technology. New York: John Wiley & Sons, 1892. 176 pages; price $2.

The aim of this work is to call attention to the importance of the accuracy of measurement of any character, and to give the best methods for obtaining the highest degree of accuracy. It is, perhaps, the student to whom this treatise especially appeals, for not alone is accuracy highly desirable in itself, but the acquired tendency in that direction is one of the most important results of a careful training.

After discussing the question of direct measurements and considering the various sources of error and the best means of eliminating them, the author takes up the question of indirect measurements and estimates the accuracy of indirect results, showing the data required to substantiate a result, and giving numerous examples to illustrate the principles set forth. The best magnitudes of components also receives the careful attention which its prominence deserves. A large number of illustrative problems are given which add greatly to the value of the work. A majority of these are taken from electricity, and include such experiments as the calibration of voltmeters, dynamo efficiency by the stray power method, the cradle dynamometer, battery resistance and E. M. F. and so forth. The engineer as well as the student will no doubt find this work of value.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Dec. 2, 1893.

GENERAL ELECTRIC was subjected so much this week to continued adverse reports of its condition as to bring out the following lengthy statement from a director: "I am glad to state most emphatically that the recent rumors affecting the General Electric Company's credit and financial condition are unqualifiedly false and without foundation in fact. Nearly all these stories are directly traceable to a certain clique of speculators known to be heavily short of the stock. From personal knowledge of the affairs of the company, I can say that its financial condition has never been so sound, so satisfactory, as at the present time. By the recent action of the directors in disposing of a block of securities to a syndicate, the company has been enabled to pay off its entire floating debt, and is left with many millions of good assets on hand, including stocks, bonds, bills and accounts receivable, etc. It has even been reported that the company would default on the interest on its debentures; whereas, as a matter of fact, there has always been and is now enough cash in the banks to pay a year's interest on its $10,000,000 of debentures. As to the company's having parted with all of its securities, the coming annual report will demonstrate the falsity of that statement. It is true that the business of the company has fallen off temporarily during the past six months, but this is readily accounted for by the fact that the largest customers are local street railway companies and electric lighting companies who have been prevented from purchasing apparatus because of their inability to float their securities or otherwise raise money during the recent financial stringency. Under the present conservative management a very close watch is kept over all of the departments, and no sales or contracts are allowed except for cash or undoubted security. Much larger sales could be made by extending credit; but it has been deemed prudent by the present management to forego prospective profits that may only be fictitious, and to keep the business of the company, at least until the general condition of business throughout the country has improved, within the bounds of absolute safety rather than to jeopardize its present sound financial condition." Yet another influential director says: "I will stake my personal reputation upon the fact that there will be no receiver." Wall Street, however, does not put the faith it used to have in these official promulgations; its experiences have taught it to be skeptical. That it was justified in its often expressed determination to disbelieve "official" statements like the above was proved when the directors met this morning and adopted the following preamble and resolution: "Whereas, The net manufacturing profits since the last dividend ordinarily applicable to the payment of dividends are offset by necessary shrinkage in customers' accounts and other assets; Resolved, That the cumulative dividend on the preferred stock be not declared at this time." There is $4,251,900 of preferred stock outstanding, on which seven per cent. per annum has hitherto been regularly paid. The dividend on the $30,459,700 common stock, on which two per cent. quarterly had been paid up to and including August, 1893, was passed Nov. 1 without official comment. The stock broke badly on the day's news. Opening at 37½ it soon sold down to 36, the closing being 35¾. This is over two points below last Saturday's quotation. One inexplicable thing is the apathy displayed toward the company by its most powerful backers. For instance, both Mr. D. O. Mills and Mr. J. Pierpont Morgan, the strongest men in the General Electric Company's board of directors, are directors of the Niagara Falls Power Company, and yet it is on Mr. Mills' motion, supported by Mr. Morgan, that the electric contract is given to the General Electric's most powerful rival, the Westinghouse Electric Company. An attempt is made to avoid criticism by stating that Messrs. Mills and Morgan are not in the Cataract Construction Company (such is the corporation title of the Niagara concern) as representatives of the General Electric Company, but the defense in many stockholders' eyes does not hold good.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY is threatening keener competition with its rivals every day. It is stated that the company is straightway to build on 23 acres of land recently secured at Brinton, near Pittsburgh, works whose capacity will make the Westinghouse company a more dangerous competitor than ever. There is to be a machine shop 754 feet long and 231 feet wide, a two-story warehouse of the same dimensions, and a suitable power house for the operation of all the machinery. The output of the new works will represent a value of $1,000,000 a month, a sum that can be greatly increased under pressure. At present the Westinghouse company employs about 2,000 hands, and this number will be largely added to as business picks up. There will be an enormous saving in expense to the Westinghouse people by moving the manufacturing plant into this establishment. The business of the General Electric Company, the principal competitor of the Westinghouse company, is conducted in works at Lynn, Schenectady and other places in over 60 separate buildings. The Westinghouse company will do all its manufacturing in one building with a consequent saving in expense of superintendence and operation.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Boston, offers to stockholders of record Nov. 30 the right to subscribe until Dec. 30 for 3,287 shares of capital stock, pursuant to a vote increasing the share capital from $2,671,300 to $3,000,000. The circular making the offer reads that each holder of 6⅛ shares is entitled to take one new share at par, payment to be made as follows: Twenty-five per cent. Jan. 5, 25 per cent. March 5, 50 per cent. May 5, when the stock will be issued, interest to be allowed on prepayments. The money is to pay for new construction. "The company," adds the circular, "would have preferred to issue more stock and make larger provisions, but this is the limit authorized without reference to the gas and electric light commission for authority, which reference would be attended with delay. . . . . The directors desire to state that, while the prevalent depression has not yet so affected the earnings of the company as to have warranted any reduction in the rate of dividends, the stockholders must realize that a continuance of the business conditions referred to may not be without its temporary influence upon our prosperity." No dealings in subscription rights have come to notice, but sellers talk of 2 to 2½ as a proper price. To each share of stock now held three-nineteenths of a right are attached.

WESTERN UNION'S QUOTATION closes this week at a somewhat higher figure than the record of last Saturday. There was a slight decline on Monday and Tuesday on sales by brokers usually credited with manipulating the stock for inside interests. Then, too, liquidation, in order to realize profits, on the part of a pool headed by "Deacon" S. V. White, helped along the temporary slump. The buying throughout the week has, however, been of the best character. Brokers often employed by prominent insurance corporations have been the most active bidders for the stock. The executive committee meets within a few days to recommend the declaration by the board of directors of the regular quarterly dividend of 1¼ per cent. The one-hundredth dividend has already been paid, and insiders are making much of the fact. The supply of stock is very small. All of the floating stock has been borrowed by the old short interest, and it is very hard to obtain for delivery except in small lots.

ELECTRIC TRACTION has been, with other traction stocks, the feature of the week in the Philadelphia stock market. This group of stocks has displayed unusual activity, and excellent support has been accorded to them.

THE MEXICAN TELEGRAPH COMPANY is not, says Vice-President Sebastian Comacho, losing any money through the revolutionary troubles. He sends word from Mexico that the Mexican government has not sequestered a single one of the numerous messages which pass daily between Mexico and abroad over the lines of the Central and South American and Mexican Telegraph companies.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., has placed $100,000 new capital stock, making $200,000 in all.

ELECTRICAL STOCKS, DEC. 2, 1893.

	Par.	Bid.	Asked.
Brush Ill., New York	50	20	40
Detroit Electrical Works	10	2	3
Cleveland General Electric Co.	..	85	90
East River Electric Light	100	..	65
Electric Con. & Supply Co. pref.	15	15	16
" " " " " com	15	15	17½
Edison Electric Ill., New York	100	95	98
" " " Ists	...	104	105
Edison Electric Ill., Brooklyn	100	98	105
" " " Boston	100	115	124
" " " Chicago	100	220	230
" " " Philadelphia	100	120	125
Edison Electric Light of Europe	..	2½	5
" Bonds	..	80	85
" Ore Milling	..	5	12
Fort Wayne Electric	..	4½	6
General Electric Company	100	35¾	36
" " deb. 5's	..	78	80
Interior Conduit and Ins. Co	100	25	35
Mount Morris Electric	..	..	65
Westinghouse Consolidated	50	25	26½
" " pfd	50	41	43
Western Union Telegraph	..	91¼	91⅝

NEW INCORPORATIONS.

THE BLAIR LAMP ADJUSTER COMPANY, Omaha, Neb., capital stock $50,000, has been formed to manufacture, buy and sell electrical supplies, patents, etc. W. J. C. Putnam, C. H. F. Roberson and Will Whitmore are interested.

THE LA JUNTA ELECTRIC COMPANY, Denver, Colo., capital stock $25,000, has been formed to furnish an electric plant for that town. C. F. Lacombe, G. A. Goddard, Denver, and A. G. Bentley, La Junta, Colo., are the organizers.

THE PROGRESSIVE MANUFACTURING COMPANY, Camden, N. J., capital stock $200,000, has been formed to manufacture and sell electrical devices, etc. S. Walsh, C. M. Keegan, Philadelphia, Pa., and J. S. Adams, Camden, N. J., are the promoters.

THE WATER AND IMPROVEMENT COMPANY, OF ST. CHARLES, St. Charles, Mo., capital stock $100.000, has been formed to conduct a system of water-works and a heat, light and power plant in that city. The promoters are H. C. Scott, T. Fox and I. H. Lionberger, St. Louis, Mo.

THE SOUTH JERSEY ELECTRIC COMPANY, Jersey City, N. J., capital stock $100,000, has been formed to generate, distribute and supply electricity for motor, light, heat or other purposes. H. A. Mandeville, W. H. Curtiss, Frank Brewer, F. A. Wright, South Orange, N. J.; S. Constanble. J. R. Weeks, and C. A. Cregin, New York City, are interested.

THE FREELAND ELECTRIC LIGHT, HEAT AND POWER COMPANY, Freeland, Pa., capital stock $15,000, has been formed to supply light, heat and power by means of electricity to that town. F. W. Bleckley and W. H. Hoyer, of Scranton, and H. E. Sweeney, of Drifton, Pa., are interested.

THE HOUGH ELECTRIC COMPANY, San Francisco, Cal., capital stock $1,000,000, has been formed to manufacture and deal in electrical apparatus, inventions and patents. The promoters are E. S. Hough, E. Hough, L. C. Harvey, C. L. Wingley, Oakland, and H. E. Wright, San Francisco, Cal.

THE MENETT ELECTRIC LIGHT, POWER AND ICE COMPANY, Menett, Mo., capital stock $50,000, has been formed to manufacture electricity for light and power purposes, etc. D. J. Young, Fort Smith, Ark.; J. F. Carr, Springfield, Mo., and W. T. Hamilton, Menett, Mo., are the interested parties.

THE GEORGETOWN WATER AND ELECTRIC COMPANY, Georgetown, Tex., capital stock $100,000, has been formed to supply water, light, heat and power to the public. A. S. Fisher, W. K. Makemson, E. E. Taylor, J. W. Robertson, Georgetown, and W. L. Vining, Austin, Tex., are the promoters.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Dec. 4, 1893.

THE NEW YORK FIREPROOF COVERING COMPANY has removed from 136 to 126 Liberty street.

MR. H. M. LOUD, of the H. M. Loud & Sons Lumber Company, Oscoda, Mich., is in town for a week or two, and may usually be found at his New York office, 18 Cortlandt street.

SUPERINTENDENT J. J. WOOD, of the Fort Wayne Electric Company, is about to place on the market an entirely new line of converters, which, he claims, will show greater efficiency and less heating than those now in use.

MR. STERENFELDT, buyer for the Compania Nacionale de Luz Electra, the municipal plant of the City of Mexico, placed some orders in this city during the week, the largest being for supplies, which he purchased from Charles E. Chapin.

MR. C. S. KNIGHT, of the Fort Wayne Electric Company, was at their New York Office during the week, and returned to Fort Wayne Saturday. Mr. Knight was in a particularly happy mood, owing to the fact that the sales of the company up to the 25th of November were really double for that month what they were for the corresponding period last year.

MR. J. J. GATES, formerly secretary and manager of the Perkins Electric Lamp Company and of the Waring Electric Company, has accepted the position of manager of the Connecticut Royal Arc Company, Hartford. Mr. Gates has just closed a three-years contract with the Hartford Electric Light Company, which will use the Royal arc exclusively on their street and commercial arc circuits.

MR. NEWTON L. SCHLOSS, electrical engineer, 28 West Fourteenth street, New York, has secured the contract for the complete installation of an arc and incandescent plant in the building occupied by Messrs. Ludwig Brothers, West Fourteenth street. Messrs. McLeod, Ward & Co., of 91 Liberty street are doing the construction work. Mr. Schloss has also lately closed contracts of the same nature as above in Baltimore, Washington and Richmond.

MR. T. J. MURPHY, of 136 Liberty street, New York, the well known manufacturer of switchboards and dealer in electrical slates, has recently formed a partnership with Mr. J. F. McGuire, under the firm name of T. J. Murphy & Co. The business has increased to such an extent during the past year that Mr. Murphy has found it necessary to form this partnership and he is particularly fortunate in securing Mr. McGuire, whose knowledge of the business and experience will make him a very valuable addtion to the firm. They have greatly increased their facilities for supplying the trade, and it is their intention to carry a large stock of marble and slate, so that all orders can be executed without delay.

STREET RAILWAY CONSOLIDATION.—There is a scheme under way in Brooklyn which has for its object the consolidation of all the surface railroad interests in that city. The holders of preferred, as well as common stock, in the Brooklyn Traction Company, have received a letter setting forth the plan of merging the Atlantic Avenue Railroad Company, the Broadway, Broadway Ferry and Metropolitan Avenue, Jamaica and Brooklyn companies into a new company, to be known as the Long Island Traction Company. The Long Island Traction Company now owns or controls the capital stock of the Brooklyn Heights Company, the lessee of the old Brooklyn City Railroad Company and the Atlantic Avenue Railroad Company. It is proposed to carry out the plan of consolidation by means of one of the existing corporations, or by a new corporation with a capital of $15,000,000, $2,500,000 to remain in the treasury unissued. It is proposed also that the new company issue $11,000,000 gold bonds, secured by mortgages on the property of the Broadway company, the Atlantic Avenue company and the Brooklyn Traction Company. The Long Island Traction Company is to have an option on all the properties of the various interests for a number of months, to be agreed upon hereafter. A syndicate will be formed to purchase all the collateral trust notes not taken by the stockholders. This scheme is intended to reach over into Queens county and take in all the city and suburban roads it can grasp. The Brooklyn, Queens County & Suburban Company has just been formed, and its certificate of incorporation filed with the Secretary of State. The capital stock of this company is $15,000,000, in 150,000 shares of $100 each. The company paid into the state treasury at once a state tax of $18,750. The directors are: Cassius M. Wicker, Francis P. Lowrey, of New York; Henry T. Bragg, of Yonkers, and Frank Bailey, Edward Johnson, George H. Southard, Henry E. Hutchinson, Fred T. Aldridge and Julian D. Fairchild, of Brooklyn.

NEW ENGLAND NOTE.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Dec. 2, 1893.

MESSRS. DRAKE, PAYSON & WHITTIER, of Providence, R. I., have been appointed agents for Providence and vicinity for the full line of electric railway supplies manufactured by the Brown Electric Company, of Boston, Mass.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 MONADNOCK BUILDING, CHICAGO, Dec. 2, 1893.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., states that after careful investigation it has decided to push the sale of the Packard transformer, believing that its superior merits will commend it to every central station man. Careful tests, both scientific and practical, demonstrate a number of points which were a surprise to even the manufacturers themselves, and the Electric Appliance Company is sanguine of its success.

SARGENT & LUNDY, of the Monadnock Block, Chicago, are now general Western selling agents for the Crocker-Wheeler dynamos and motors. This firm, of which Mr. Frederick Sargent is the head, is paying particular attention to the equipment of power plants for the transmission of electricity over long distances to mills and factories. Sargent & Lundy are just now giving particular attention to the sale of Crocker-Wheeler apparatus, and report very satisfactory results.

THE GREAT WESTERN MANUFACTURING COMPANY finding its business growing so large in all sections of the country, has decided to open two additional district offices on Dec. 15. The most important of these will be located in the Temple Building, Pittsburgh, Pa., under the charge of Messrs. Henry & Greim. The other is at Los Angeles, Cal., under the direction of that well known electrical pioneer, Mr. W. H. N. Noble. These two offices, together with those already in active operation, make a total of six district offices of this enterprising company.

GEORGE G. CARTER & CO. is a new name on the list of prominent Western electrical firms doing an exclusive selling business. The head of this firm, Mr. Geo. G. Carter, was for seven years Chicago city salesman for the Ansonia Electric Company, and during the World's Fair had charge of the handsome exhibit of that company in the Electricity Building. Mr. Carter and his associates have many friends in the business, and their success promises to be immediate. They have already secured agencies for the following concerns: American Carbon Company, of Dayton, O.; the Pumpelly-Sorley Storage Battery Company, of Chicago, and the Hattery Manufacturing Company, as well as a general agency for nearly all standard electrical specialties. Their office is now at No. 1563 Monadnock Block, Chicago.

THE NEW CATALOGUE of the Central Electric Company, of Chicago, is winning for that well known house many flattering compliments. It is the fourth edition of the company's general catalogue, and may be said to be the most complete work ever published by an electrical house. The first few chapters are devoted to the price lists of "Okonite" wire very artistically arranged and neatly printed. Next comes a complete description of Lundell motors, together with prices. Following this is presented a complete catalogue of all the product of the Interior Conduit Company, of which line the Central Electric Company is the general Western agent. The cuts in this department as well as the reading matter are especially attractive. Then follows an elaborate treatise on construction material, incandescent light supplies, arc light supplies and general station supplies and material. The chapter on instruments is particularly exhaustive, covering 71 pages. The book concludes with many tables of great value to electricians and station managers. The size over all of the catalogue is 11 by 8 inches, and the total number of pages 525. It is neatly bound in cloth with gold letters. In size, appearance and completeness, the new catalogue of the Central Electric Company is deserving of a place on the desk of every one who desires to have before him a complete treatise on all electrical supplies.

PORTLAND, Ore., Nov. 27, 1893.

HENRY RUSTIN has been appointed superintendent of the East Railway Company's lines, of Portland, Ore.

CLARK SMITH has sold his central station electric lighting plant in Independence, Ore., and is now with the Union Power Company, in Portland.

THE CITY & SUBURBAN RAILWAY COMPANY, of Portland, Ore., was the defendant in a suit for damages brought by Claude I. Scoffin. The jury awarded the plaintiff $5,000.

THE PORTLAND GENERAL ELECTRIC COMPANY has commenced pumping out its cofferdam at the site of the new Oregon City electric station for the third time. The company has suffered considerably by unexpected rises of the river, but no expense is being spared to complete the work as soon as possible.

CHAS. E. SMITH and associates have been granted a franchise by the city of Portland, Ore., to construct and operate an electric railway on First street, with extensions north and south. The amended franchise, as passed, requires a double track line on First street. The new line would replace the single track horse car line now in operation on the above street.

THE PORTLAND GENERAL ELECTRIC COMPANY recently installed an additional 1,500-light Westinghouse alternating machine, which is now in operation in the Oregon City station. The company is testing some of the new General Electric alternating arc lamps on its incandescent circuits.

CANADIAN NOTES.

OTTAWA, Dec. 2, 1893.

LONDON, ONT.—Tenders are called for by the city engineer for an arc electric light plant for this city, including boilers and engines.

BELLEVILLE, ONT.—It is understood that the city has received a proposition from another company to put in an electric street railway system. The committee, as with the other companies, requests from the General Electric Company a deposit of $1,000 as a guarantee of good faith and the obligation within a reasonable time to construct a belt line.

OTTAWA, ONT.—Notice is given that the Dominion Burglar Guarantee Company will apply to the Parliament of Canada at the next session for an act to enable the company to operate an electric wire protection service and a patrol service, both for protection against burglary; also for power to insure parcels or packages of merchandise while in transit against loss from any cause whatsoever.

HAMILTON, GRIMSBY & BEAMSVILLE.—Work has started on this electric road and is to be completed by June 1 next. The company has $70,000 of stock subscribed and $10,000 paid up. The total authorized stock is $200,000, but only half of that amount will be issued by the directors. It is expected that the funds will be raised in this way: Subscribed stock, $100,000; bonuses, $28,000; bonds, $22,000.

PLACENTIA, NEWFOUNDLAND.—George N. Carson, manager and electrician of the cable station at Placentia, Newfoundland, died at that place on the 5th ult. He was born in Pictou, Aug. 16, 1847. His parents were Scotch, from Dumfrieshire, the land of Burns and of Carlyle. At the age of 13 he entered the telegraph office in Pictou; later he worked in the Sackville office, Nova Scotia; thence he went to Heart's Content, Newfoundland, in 1867; to St. Pierre in 1870, and to Placentia in 1872, where he continued till his death.

OTTAWA, ONT.—The following resolution has passed the City Council: "That in view of the necessity of the city providing its own electric lighting plant for street lighting and other purposes the city clerk be instructed to write the Ottawa Electric Light Company and ask on what terms they would be willing to sell their plant, giving the details of the cost of the machinery on hand and the water power privileges they possessed in approximate horse power, with a view of opening negotiations for the purchase of the same, and that the company be asked to return an answer before Dec. 15."

OTTAWA, ONT.—Representatives of the street railway interests of Toronto, Hamilton, London, Windsor, Port Arthur and Montreal, with Messrs. Soper and McRae representing the Ottawa Electric Street Railway, interviewed this week the Controller of Customs, the Premier, the Minister of Finance and Sir Adolphe Caron and Hon. Mr. Daly on the subject of the duty on steel rails. When imported for ordinary railways, steel rails weighing over 25 pounds to the yard are admitted free of duty, while for tramways a duty of $2 a ton is exacted, and the customs people have all along classified rails imported for street railways under the latter head. It was to have this decision reversed that the deputations waited upon the government. The object was discussed at length, and a suggestion made that the question should be referred to the exchequer court as a test case. Sir John Thompson replied that the government could not depart from the decision of the customs department, but he would be willing to expedite a legal decision of the question.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Nov. 22, 183.

THE GOVERNMENT AND THE NATIONAL TELEPHONE COMPANY.—The laying of the draft agreement between the government and the National Telephone Company, setting forth the terms upon which the trunk wires are to be taken over by the government, and the relations which are in future to subsist between the high contracting parties, continues to be postponed from week to week. This delay arises, it is believed, from the constant cropping up of fresh points of difference.

ELECTRIC MAIN ACCIDENTS.—In spite of what we flatter ourselves is superior work, our electric mains continue to follow the example set by your own two or three years ago, and to indulge in frequent, alarming and mysterious explosions. The latest mishap occurred at Manchester, where a junction box into which several lines of mains conveyed, caught alight. Exactly how it occurred, none at present knows. I may remark that the Manchester mains are partly bare copper strip in iron troughs and partly insulated cables in iron pipes, and an endeavor is made to ventilate them by means of a fan. As, however, English air is not famous for its dryness or purity, it would seem as if the system adopted on your side of the water of forcing dried air into the mains would be preferable.

MUNICIPAL LIGHTING.—The Cheltenham Town Council has definitely decided upon spending £16,000 on electric lighting. The system is to be the now fashionable one of alternate current transformer sub-stations. As was to be expected the bills for the electric lighting of the streets of the city of London each time they come up for payment call forth protests from the advocates of economy and gas. The electricians, of course, are able to show that by replacing 1,220 16-c. p. gas lamps by 478 1,000 c. p. arcs 23 times as much light is given by electricity as was formerly given by gas. However this may be, it is not to be gainsaid that the lighting of the streets is not now 23 times better than it formerly was, nor is it, perhaps, even twice as good, or in the ratio of the relative costs of the two systems. On the other hand, the capital which has been made by the opponents of electric lighting with regard to lamp failures during the past six months is reduced to a minimum, when, instead of merely stating that so many hundred lamps have failed, it can be shown that out of a total of over three-quarter million lamp hours, the failures only amounted to 370 lamp hours.

News of the Week.

ELECTRIC LIGHT AND POWER.

HOMER AND NEWMAN, ILL., want the electric light.

HIAWATHA, KAN., is talking of investing in a municipal plant.

MARIETTA, PA.—The electric light scheme in Marietta still hangs fire.

WINONA, MINN., is considering the question of setting up a municipal plant.

BENTON, KY.—J. R. Lemon is interested in the establishment of an electric light plant.

DAWSON, GA.—A. J. Baldwin & Co. will investigate the matter of an electric lighting plant.

LITITZ, PA.—The Warwick House Hotel is being improved. Landlord Snaveley will introduce electric light.

GREENVILLE, IND.—A franchise has been granted to E. Lawrence to put in an electric lighting plant.

BROOKLYN, N. Y.—It has been decided to use electricity for operating the draw on the Vernon avenue bridge.

CATAWISSA PA.—Judge Shurman is booming a scheme for establishing a water-works and electric light company at Catawissa.

WOBURN, MSS.—Both the aldermen an dCommon Council have passed for the second time a resolution favoring municipal lighting.

FREDONIA, N. Y.—The board of trustees of Fredonia have granted a franchise to the electric company to build an incandescent electric light plant.

FAYETTE CITY, FAYETTE COUNTY, PA.—Col. Joseph A. McKee proposes to light Fayette City by electricity, power to be furnished by his flouring mill.

ST. BERNARD, O.—The question of water-works and electric light is being agitated, and it is likely that the matter will be put to vote before many days.

SAN DIEGO, CAL.—The joint electric light committee recommended that the city acquire its own electric light plant, and that the matter be submitted to the people by special election.

FAIRHAVEN, VT.—The Hon. Jas. R. Langdon has met the village trustees in the matter of electric lighting for the village, and it is as good as settled that the village will have the light by Jan. 1.

PECATONICA, ILL.—Samuel Corwin, of Rockford, has purchased the Pecatonica electric light plant, which has been shut down for over a year, and will build a new power house and start up again.

THE ATCHISON GAS, ELECTRIC LIGHT AND POWER COMPANY has reduced its rates for 16-c. p. incandescent lights burning to 10:30 p. m. to 75 cents a month, the company furnishing the wiring and lamps free.

ROMEO, MICH.—It has been unanimously voted to instruct the Common Council to grant a franchise to the International Electric Company, of Detroit, for the lighting of the village. Fifteen arc lights are recommended, with 1,200 c. p. each.

CAMBRIDGE, MASS.—The joint committee of Cambridge appointed to consider the matter of a municipal street lighting plant, reported in favor of the purchase of the present gas plant from the owners and the operation of same by the city.

EDINBURGH, IND.—A committee has been appointed to look after the matter of putting in an electric light plant in connection with the water-works. The committee consists of Henry Maley, Wm. Threlkeld and R. M. Howe, all of Edinburgh.

CROTON FALLS, N. Y.—George Juengst & Sons, who propose to light Croton Falls by electricity, also contemplate extending the system to Carmel, N. Y., in response to a general demand. They are erecting a large building just east of their iron factory, to be used as an electric light station.

CHICOPEE, MASS.—The order providing for taking vote of the people in the matter of buying the plant of the Chicopee Electric Light Company and operating of the same by the city failed of passage at a meeting of the board of aldermen, the vote being a tie. The sentiment is very strong and the matter will surely come up soon again.

MARYSVILLE, KAN.—The Marysville Light and Power Company is going to move its electric plant back to the city and run it by steam instead of water power as at present. The company will put in a new 100-h. p. engine and boilers of sufficient capacity to run the dynamos under all circumstances. George W. Parrish is secretary of the company.

BROCKTON, MASS.—Much opposition has lately developed to the proposal that the town shall have its own plant, to be voted on at the coming election, it being the general feeling that the city is already pretty heavily in debt, and that it would cost more than the finances at present justly would allow to purchase the plant of the Edison Illuminating Company.

DETROIT MUNICIPAL PLANT.—The public lighting commission is discussing the specifications which Engineer Dow prepared for the dynamos of the proposed plant. These specifications call for the largest and latest dynamos, which would probably have to be specially made for Detroit. The consulting engineers, Prof. Carhart, of Ann Arbor, and Frank B. Rae, of Detroit, advised that smaller dynamos, such as are kept in stock, be purchased.

LITTLE ROCK, ARK.—An ordinance has been passed, appropriating $30,000 for an electric light plant. The new plant which it is proposed to buy will furnish power for 260 lights of 2,000 c. p. each. The board of public affairs will receive bids to Dec. 8 for rebuilding the electric light station, bids for installing, increasing and altering the mechanical equipment of the electric light plant and bids for certain electric supplies. H. C. Jones is city clerk.

PITTSBURGH, PA.—Sealed proposals will be received at the office of the East Pittsburgh Improvement Company, Room No. 11 Westinghouse Building, to noon, Dec. 16, for machine shop and warehouse for the Westinghouse Electric and Manufacturing Company, at Brinton, Pa. Bids will be received for the entire work or for the separate parts, as per specifications and blank forms of proposals on application to J. R. McGinley, vice-president of the East Pittsburgh Improvement Company.

THE ELECTRIC RAILWAY.

DALLAS, PA.—Ground has been broken here for the new Wilkesbarre & Harvey's Lake Electric Railroad.

BAY HEAD, N. J.—There is talk of an electric road to Point Pleasant, but nothing definite has been done.

STAMFORD, CONN.—Darien, Conn., has voted to allow the Stamford Electric Railway to extend its line to that place.

NORTHAMPTON, MASS.—The Northampton Electric Railway Company has begun survey for its proposed extension to Williamsburg, eight miles.

CARLISLE, PA.—The Town Council of Carlisle has granted a franchise to the Cumberland Valley Electric Railway for building a motor line through the streets of Carlisle.

EAST ORANGE, N. J.—The East Orange township committee has granted a franchise to the Suburban Traction Company, allowing it to equip its road on Dodd and Prospect streets with electricity.

PORTSMOUTH, N. H.—A resolution has been passed appointing a committee to confer with the projectors of the Portsmouth horse railroad in regard to being allowed to use electricity as a motive power.

NORTH ABINGTON, MASS.—At a meeting of the Rockland & North Abington Electric road, at their offices on North avenue, in North Abington, it was decided to extend the road to a point near Assinippi and Hanover.

RUTLAND, VT.—A special to the Boston "Journal" states that an electric road between Rutland and West Rutland is now a certainty, but no names are given. These two points are now connected by a horse railroad.

ST. GEORGE, STATEN ISLAND, N. Y.—A movement is on foot to establish an electric line along the north and east shores of Staten Island, independent of the present belt lines, and prominent politicians are said to be back of the movement, but nothing definite has yet been done.

TIFFIN, O.—F. W. Brightman, of Fall River, Mass., and Chas. F. Shaw, of New Bedford, Mass., who own the Tiffin horse car line, have decided to amalgamate with the Tiffin Electric Railway Company and the Tiffin-Fostoria lines. They propose to equip the entire system with electricity after completing the Fostoria line.

POTTSTOWN, PA.—Contractor Peter Willauer has broken ground for the tracks of the Citizens' Passenger Railway Company. President J. Mortimer Lewis, of the company, will not state whether the company will operate the road itself when completed, but it is believed that the road will be sold to the Ringing Rocks Electric Company.

MOUNT CARMEL, PA.—Major Hamilton, of Shamokin, Pa., is the prime mover in the proposed Shamokin & Mount Carmel Railway. Surveyors Clapp and Boyer are now going over the road. Major Hamilton is also interested in the proposed Sunbury & Selinsgrove Electric Street Railway, for which a charter was granted two years ago, with provision that work should be commenced within two years. A few sods have been turned.

HALIFAX, N. S.—The Halifax Street Railway and Motor Company some two years ago obtained a charter from the legislature to operate an electric railway in Halifax, but owing to internal dissensions the change from horse power was not made. Recently the company submitted to councils a plan and specifications for operating the railroad, and City Engineer F. W. Doane has recommended its acceptance by the authorities. It is intended to operate by the trolley system.

THE CARBONDALE (PA.) AND FOREST CITY RAILWAY COMPANY has elected as president Jno. W. Aitken, of the Carbondale Traction Company, and will begin April 1 to build 15 miles of 60-pound "T"-rail track. Two native stone buildings will be erected for power house and car barns, and a combination stone and wood pavilion and refreshment stand will be built at Crystal Lake Park, where the company has secured 100 acres of park land on the lake shore. Twenty summer open cars, two double-decked and one palace car, will be equipped with 25-h. p. motors on each axle, and 10 miles of the road must be in operation by July 1. The power plant will consist of Corliss engines of 1,000 h. p. and four steel tubular boilers, with a traveling crane the entire width of the building. Although the company holds franchise for the public roads after leaving the city of Carbondale, the line will be upon land secured by the company, and the distance between the towns will be greatly shortened and good grades secured. The road connects the rapidly growing city of Carbondale with Vandling, Richmondale, Forest City, New Buffalo, Dundoff, Crystal Lake, Mayfield and Jermyn. The farmers in and around Dundoff have guaranteed to supply sufficient number of cans of milk to insure the company $10 per day from that item of freight alone. Crystal Lake being the great resort for a contiguous population of 150,000 people, will insure the company an excursion business of more than $500 per day during the season. By this line the Lackawanna and Susquehanna valleys will be united by a continuous line of 50 miles of electric rapid transit.

THE PEN ARGYL, BANGOR & WATER GAP ELECTRIC STREET RAILWAY, now under construction, extends over a distance of about 30 miles in the eastern part of Pennsylvania. Commencing at Stroudsburg, it leads through the Delaware Water Gap section, and thence through the slate belt region of Northampton county, passing through the towns of East Stroudsburg, Water Gap, Stateford, Portland, Upper Mount Bethel, Johnsontown, East Bangor, Bangor, West Bangor, Pen Argyl and Wind Gap—a region of about 30,000 industrial population. The road is designed not only to meet the customary demands of travel between closely situated towns, but for the carrying of workmen to and from the quarries, some 40 in number, along the route, employing from 50 to 500 men each. The electric power, as supplied from the power houses of the railway, will also be sold for the operation of the hoists, drills and finishing machinery of the quarries, as steam power is expensive on account of the required frequency of change of location of operation, as well as the inconvenience attendant thereupon. At the eastern end, the construction passes over the western divide of the widely known Delaware Water Gap, from which a summer resort traffic of heavy proportions is to be accommodated, since many years from six to ten thousand all summer visitors from the cities are to be found between Portland and Stroudsburg, while transient excursionists to the number of 200,000 were recorded in 1892. Along the line is a field for summer hotels unequaled by any of similar convenience of access in the United States. There will be two power houses of 500 h. p. each, with four 250-h. p. Belmont engines and four Westinghouse dynamos. The officers of the company are representative citizens of the town of Sunbury, Pa.: A. J. Stroh, Esq., president; Silas Conrad, vice-president; J. B. Reed, treasurer, and Geo. B. Renn, secretary. The western section of the road is to be completed this fall, and the remainder by July 1, 1894. Chas. E. Manning, of New York, is the engineer and contractor. The main office of the company is at Bangor, Pa.

MISCELLANEOUS NOTES.

STORAGE BATTERY CARS IN PARIS.—A new storage battery street railway line has been inaugurated, running from the Bastille.

QUITE A DIFFERENCE.—It is reported that experts employed by the Tacoma, Wash., Board of Public Works have estimated the electric plant recently purchased from the local company for $1,750,000 as being only worth $740,000.

WEEKLY PAYMENTS TO TELEGRAPH OPERATORS.—The New York State factory inspectors have ordered the Western Union Telegraph Company to pay its employees weekly instead of semi-monthly as heretofore, and after Dec. 1 this system will be adopted.

UNDERWRITERS' RULES.—Mr. L. G. Lilly, underwriters' inspector for Cincinnati, is determined that the standard for electric wiring in that city shall be at the top notch. Recently a meeting of the contractors and station men was called in order that all might have the same understanding of the new rules, which will be enforced. There is talk of organizing an electrical club.

THE THOMSON SCIENTIFIC CLUB, of Lynn, Mass., cleared about $110 on a recent lecture given by Prof. Thomson. The club has always been in excellent condition and has at present over 50 members in good financial standing and as many more associate and honorary members scattered over all parts of the country. The club will have a lecture course early in the new year.

CULM AS FUEL.—Culm, or the waste screenings of coal, has recently come into use as a fuel. Formerly, from not knowing how to burn it, any attempt at its use only resulted in extinguishing a fire, and, as a consequence, it was regarded as a waste product. With new methods it is claimed that culm can be burned as readily as larger sizes of coal, and as it can be bought as cheaply as five cents a ton at the mines, the saving that may result from its use is evident.

THE TRENTON DAM.—Work on the wing dam in the Delaware River, at Trenton, has been commenced. The company will extend their dam only half-way across the river, because the Pennsylvania legislature refuses permission to dam their side of the river. The dam company owns the Pennsylvania River front for a mile, but cannot build from it. The New Jersey side will afford water power through a number of sluiceways and these will operate a number of large turbines that will supply electric power.

THE BUREAU INTERNATIONALE DES ADMINISTRATIONS TELEGRAPHIQUES, Paris, will issue during the next year an official vocabulary containing about 240,000 words drawn from eight languages; English, French, German, Italian, Spanish, Dutch, Portuguese and Latin. The words will contain at least five letters and not over ten, and will be numbered consecutively from 1 to 240,000. Three years after the appearance of the book its use will become obligatory in the European telegraphic service.

A COMMENDABLE SPIRIT.—At the beginning of a recent disastrous fire in Springfield, Mass., the electric street railway officials sent out men to investigate the locality of the fire and to report as to whether they could be of assistance. When the flames began to spread, a man was stationed at each guy pole with a ladder and with instructions to cut the wires as fast as the fire spread, and to leave nothing undone which would tend to aid the firemen in their efforts. The instructions were carefully followed, and faster than the firemen could move the ladder trucks and aerial hose lines the way was made clear of all obstructing wires.

ELECTRICITY IN ITS INFANCY.—In Philadelphia recently an electric light consumer disputed his bill, on the plea that the meter did not register correctly. The defense was that electric lighting or the science of electricity is in its infancy; that the company had adopted a meter, which was, in their judgment, the best that could be found, and that the defense was insufficient because the affidavit did not set up in what respect, manner or particular the meter was incorrect, and that it gave no standard by which its correctness or incorrectness could be tested. The court sustained this view and entered judgment for want of a sufficient affidavit of defense.

A DANGEROUS ILLUMINANT.—Owing to a gas governor freezing during the night at Evanston, Ill., recently, the gas was temporarily shut off, and later, when the pressure was renewed in the mains, the gas escaped through the jets in houses where it had been previously burning. A citizen who made the discovery telephoned to the mayor, who at once had the police force called out to go from house to house to warn the occupants, and the telephone exchange called up all of its subscribers for the same purpose. Owing to these precautions and to the fact that the pressure was very small, no one was seriously asphyxiated.

LICENSING WIREMEN.—The full text of the resolution of the New York Board of Underwriters, to which we referred in a previous issue, is as follows: "Resolved, That the president of the board be authorized to address a communication to the Governor of the State of New York calling his attention to the enormous increase of fire waste of late years, due largely, in the opinion of the underwriters, to the improper wiring of buildings for electric lights or power, and asking his influence to secure legislation which shall require that no person shall be permitted to wire buildings for electric light or power purposes who has not been duly licensed as competent to perform the task by some board of control competent to test the qualifications of applicants for licenses, as is now the case in connection with engineers having charge of boilers, etc."

PROF. MASCART'S IMPRESSIONS OF AMERICA.—At the first meeting of the Societe Internationale des Electriciens after the summer vacation, held on the 8th of November, Prof. Mascart gave an account of his recent travels in the United States, accompanied with photographic views projected on a screen. Prof. Mascart spoke of his impressions derived from a stay in New York and trips to Niagara Falls, Montreal, Mount Washington, Boston, Philadelphia, Baltimore, Pittsburgh, Yellowstone Park and elsewhere. He referred to the work of the International Congress of Electricity, and notably to its decision in regard to the substitution of the word henry for quadrant as the unit coefficient of induction. Prof. Mascart laid stress upon the great activity of electrical industries in America and the extent to which they are carried, stating that it is not unusual to find dynamos of 500 and even of 2,000 h. p.

A BIG CHIMNEY.—One hundred men dined recently within the base of the great chimney of the power house of the Brooklyn City Railroad Company. The chimney is 300 feet high, the highest in New York and one of the highest in the world. It has a greater cubic capacity, however, than any other, and is intended to supply the draught for boilers aggregating 18,000 h. p. The chimney proper has an inside diameter of 17 feet and has walls averaging 3½ feet in thickness. It is 60 feet square across the base, outside measurement, and tapers to a diameter of 27 feet at the top, which is crowned with an iron cap weighing five tons. The weather surface is faced with pressed brick, the backing is North River brick and inside, running from the base to a height of 75 feet, is a lining of firebrick. Two million bricks were used, laid with the best Portland cement. The total cost of the chimney was $60,000. One thousand and one piles were driven as a sub-foundation, 60 feet square, on what was once the river bed. Five feet of concrete were placed on the piles, the interstices having been packed with concrete. Eight feet of granite were built on this bed, and the walls of the flues and chimney were placed on this solid footing.

ELECTRIC RAILWAY REGULATIONS.—The Brooklyn grand jury has made the following recommendations, with a view to lessen trolley accidents: The speed of the electric cars shall be limited to eight miles an hour, and this speed shall not be increased at any time or between any points on the car route. A man shall be stationed at all times at the intersection of the different car routes, who shall have authority to govern the speed of the cars at these intersections. No man shall be employed as motorman who has not had at least one month's actual experience in operating electric cars. An electric bell shall be applied which will make a continuous sound at crossings, while being operated by the motorman or conductor. The several electric railroads shall apply to the front part of each car in use a guard for the better protection of the traveling public. The front platform of each car shall be supplied with gates. The police department shall give special instructions to the officers and patrolmen to arrest any motorman who may be running his car at a greater speed than eight miles an hour. The proper officers of the county and city governments shall be requested to make such laws or ordinances as will be proper for the fulfillment of these recommendations and to be made effective at as early a date as possible.

Trade and Industrial Notes.

THE FARRAND & VOTEY ORGAN COMPANY, Detroit, Mich., is now building electric organs exclusively.

THE W. S. HILL ELECTRIC COMPANY, Boston, Mass., recognizing the large demand for a light, compact covered 500-volt fuse block, has produced a neat and efficient form, which we illustrate elsewhere, thus showing its ability to keep fully up to the times in this line, as well as in switches and switchboards.

MR. A. D. ADAMS has resigned his position as electrician and manager for the Commercial Electric Company, and will shortly place on the market a line of his improved dynamos and motors. His well known all-forged magnet construction will be retained in his new machines and the valuable feature of fireproof insulation for armatures added.

THE GREAT WESTERN MANUFACTURING COMPANY, through its Denver office, reports the following recent sales: One 12-kw. direct current dynamo; one 30-kw. alternating current dynamo, and one 25-kw. direct, with a large quantity of supplies. The company also reports increased sales in all sections of "Clark" wire, of which it is the general western agent. It is also preparing a new and very complete catalogue, which will be ready in about two weeks.

THE CENTRAL ELECTRIC COMPANY report large sales on the various grades of the P. & B. paints and varnishes, which they are handling as general Western agents for the Standard Paint Company. Their stock represents the different grades of these products, put up in packages ranging from one gallon to a barrel. They also report that their sales of Anti-Thunderbolt oil paper show a large and increasing demand for a product of this nature, which is absolutely reliable. This paper is a preventive for short circuits and grounds when used in winding armatures, fields and converters and is unsurpassed for electric manufacturing and repairing. It will resist the highest voltages, also the action of oil, water and dampness and the injurious action of chemicals and gases, and it does not crack or tear when folded. The genuine oil paper is stamped "Anti-Thunderbolt."

THE ALLEN ELECTRIC AND SUPPLY COMPANY, No. 232 Carter street, Philadelphia, Pa., will handle the Graham trucks in all the States lying between the Hudson River on the east and the Mississippi River on the west. The increased orders taken for the truck recently and the great number of inquiries in the Middle States section made it imperative on the part of the Consolidated Railway Supply Company, Boston, to have a competent agency in this territory. The truck will be made in Philadelphia complete. The Allen people will have a complete truck at their office, No. 232 Carter street, to show. The spring suspension device of the Graham truck absolutely prevents that teetering motion which is so detrimental to the life of the car body, and at the same time relieves the rail joints and switches of the hammer blow of the wheel, as must be the case in the rigid trucks.

THE RIES ELECTRIC SPECIALTY COMPANY, of Baltimore, Md., the manufacturer of the well known Ries regulating sockets and switches, has removed its offices and factory from its old quarters at the corner of Baltimore and Eutaw streets, to the large and commodious Gunther Block, No. 7 South Gay street, where it has installed additional machinery and will have ample room and largely increased facilities for manufacturing the goods which its growing trade demands. In addition to its established products, the Ries Electric Specialty Company is now busily engaged in manufacturing the new Ries & Scott single-phase alternating current motors, for which the company has numerous orders already booked for early delivery. The smaller sizes of these motors will shortly be ready for the market, and will be rapidly followed by others of larger capacity, which will compare favorably with the best continuous current apparatus and will give a decided impetus to the introduction of motors on alternating current circuits.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N.Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED NOV. 28, 1893.

(IN CHARGE OF W. A. ROSENBAUM, 177 TIMES BLDG., N.Y.)

506,622. CONDUIT ELECTRIC RAILWAY; Edward H. Johnson, New York, N.Y. Application filed May 16, 1892. A conduit for electric railways, having a conductor chamber, the diameter of which decreases continuously from its surface opening to its bottom, and said opening being the full width of the chamber at that point.

509,363. ELECTRIC CURRENT REGULATOR; John H. Clark, Boston, Mass. Application filed Dec. 30, 1891. In a current regulator a stop for limiting the extent to which the movable member thereof can be moved and means for imparting a retarded movement to the said member after the stop has been set.

509,367. SWITCHBOARD CIRCUIT AND SIGNALING APPARATUS; F. W. Dunbar and E. S. C. May, Newark, N. J. Application filed March 7, 1892. The combination with each main circuit of a call annunciator having two helices, one included permanently in the main circuit and adapted, when energized, to give the signal, and the other included with a source of electricity in a normally discontinuous local circuit arranged to be completed by the act of inserting a plug connector in any plug socket of the main line and to remain closed so long as such plug occupies its socket, the second helix acting during such time to oppose and neutralize the action of the first helix and prevent the signal from being given.

509,381. BATTERY BOX AND CASE; L. F. Jordan, Somerville, Mass. Application filed Oct. 3, 1892. A battery box containing a number of battery cells having longitudinal contact strips on its side and bottom connected to the terminals of the cells, combined with the battery box case having spring contact plates connected to the side of the case to make abutting electric contact.

509,397. ELECTRIC ELEVATOR; C. R. Pratt, New York. Application filed Feb. 5, 1892. In an electric elevator system the combination of an electric feed circuit, the armature of a driving motor therein, a brake, a circuit breaker in the feed circuit, means for relieving the brake, an electromagnetic device independent thereof for applying the brake and opening the

509,403. ELECTRIC CLOSED CONDUIT SYSTEM FOR RAILWAYS; G. W. Von Siemens, Berlin, Germany. Application filed April 13, 1892. The combination with a main feeder of a series of insulated conductors adapted for contact with a contact device on the car, magnetically operated circuit devices for successively cutting said conductors into and out of circuit, magnets for operating said circuit devices, relatively located on the car at a greater distance apart than the distance between the circuit devices, and contacts and connections whereby the magnets of said circuit devices are respectively polarized in advance of the passing over them of the car magnets.

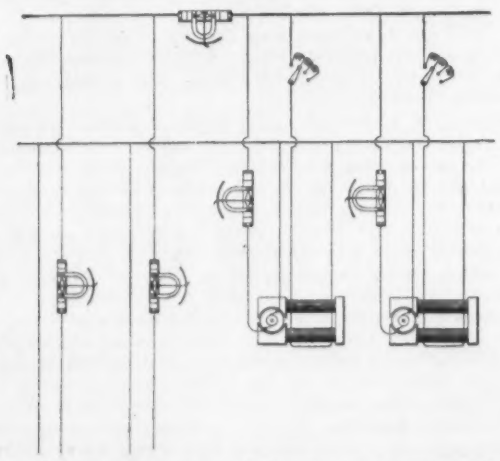
509,421. CONDUIT ELECTRIC RAILWAY; Adolph Worner, Budapest, Austria, Hungary. Application filed Nov. 12, 1891. In an electric railway, the combination with an underground conduit and continuous electrical conductors suspended therein by insulated supports, of a compound spring, the parts of which are rigidly connected at their ends so as to form in effect a single spring, carried by the moving vehicle, for pressing contact shoes carried thereby against the continuous conductors and means for transmitting the current to the vehicle.

509,430. PRINTING TELEGRAPH; R. A. Fowden, Philadelphia, Pa. Application filed Jan. 31, 1893. A printing telegraph system, comprising relay electromagnets adapted to control local motor circuits at the transmitter and receiver and responding to makes and breaks in a line circuit, and a revoluble circuit maker and breaker interposed in the conductor of the line circuit and mounted on the transmitter type-wheel shaft.

509,443. ELECTRIC LIGHTING SYSTEM; J. B. McGiffert, Elizabeth, N. J. Application filed March 24, 1893. A switchboard comprising several series of bearings, a contact lever for each series fitted removably and interchangeably to the bearings thereof, and contact clips adjacent to the bearings of each series.

509,445. COMBINED ELECTRIC MOTOR AND INDUCTION COIL; J. S. Nowotny, Cincinnati, O. Application filed April 5, 1890. A contact consisting of a sleeve and an elastic tapering plug formed of a coil of wire, connected to another wire of the circuit, the sleeve receiving the elastic plug when the circuit is to be closed.

509,447. TRAIN SIGNALING APPARATUS; J. S. H. Pellat, Paris, France. Application filed Aug. 10, 1892. The combination of a series of train operated circuit closers arranged along a railway line, a series of styluses placed at intervals along the axial line of a drum which is connected to one pole of the battery, each circuit closer being connected to the other pole of the battery, and being in a separate circuit with its



No. 509,517.—SYSTEM OF ELECTRICAL DISTRIBUTION.

correspondingly located stylus, a uniformly moving band of suitably prepared paper passing between the drum and the styluses, whereby, as the train proceeds, and successively effects the closure of the circuit of each stylus, a dot is marked on the moving paper at the corresponding stylus, which indicates the position of the train upon the line, the series of dots thus produced forming a curve of the progress of the train in rectangular co-ordinates.

509,475. COMPOUNDING DYNAMO-ELECTRIC MACHINE; W. H. Knight, Lynn, Mass. Application filed Feb. 6, 1893. The method of adjusting an electric coil, which consists in varying the compounding effect of the coil while maintaining a constant resistance between its terminals.

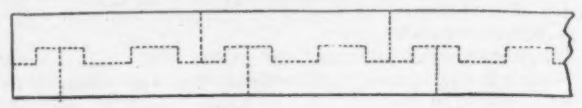
509,477. TRUNK LINE SIGNAL; E. S. C. May, Chicago, Ill. Application filed April 17, 1893. A selective relay, comprising an operating magnet having a primary and a secondary coil, a locking magnet connected with the secondary coil, an armature arranged to be controlled by the magnets, and a permanent magnet connected to the core of the operating magnet.

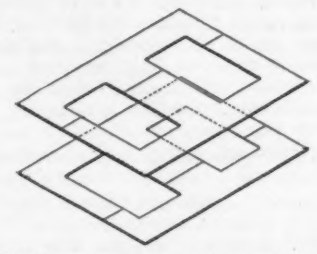
509,484. A telephone system comprising a signal, a telephone connected therewith, a transmitter, an induction coil therefor, and a battery in a local circuit, a telephone hook switch and suitable means whereby the hook switch is caused to make and break the local transmitter circuit in order to produce an induced current adapted to operate the signal.

509,486. COMPOUNDING DYNAMO-ELECTRIC MACHINES; H. F. Parshall, Lynn, Mass. Application filed May 11, 1893. An apparatus for adjusting the current passing in an electric coil without varying the resistance thereof, which consists of a resistance in series with the coil, and a second resistance in shunt to a portion of it.

509,499. REGULATOR FOR DYNAMO-ELECTRIC MACHINES; E. Thomson, Swampscott, Mass. Application filed April 11, 1893. The combination of two or more compound-wound dynamo-electric machines working in multiple arc and connected by an equalizer, with means for adjusting individually and with relation to one another the field strength of the different machines due to their respective series windings.

509,500. ELECTRIC DOUBLE POLE FIXTURE CUT-OUT; H. E. Werline, Lancaster, Pa. Application filed Feb. 15, 1893. An electric fixture cut-out divided through and longitudinally of the pipe or stem opening thereof into segments separably connected by electrical conductors.





No. 509,770.—LAMINATED CONVERTER CORE.

509,501. ELECTRIC PENDANT CUT-OUT; H. E. Werline, Lancaster, Pa. Application filed April 17, 1893. The combination with a base having a chamber in its lower face, of filling blocks secured beneath the top of the chamber, contact plates attached to the bottom of the filling blocks, arms connected with the "fast" ends of the contact plates and projecting through the sides of the cut-out and supporting the line wires, a cap having plates secured thereto and connected with the lamp wires, and hooks on the cap plates engaging the contact plates.

509,505. SWITCHING APPARATUS FOR ELECTRIC MOTORS; Parvin Wright and Joseph Kinsey, Denver, Colo. Application filed Nov. 15, 1892. A switch having a double starting electromagnet or solenoid operatively connected to a current varying device as a rheostat and a pair of double solenoids provided with mechanical and electrical connections for reversing the direction of the current through a translating device.

509,517. SYSTEM OF ELECTRICAL DISTRIBUTION; T. A. Edison, Menlo Park, N. J. Application filed Dec. 12, 1883. The combination of two or more dynamo-electric machines, having their armatures connected in multiple arc with a single circuit, and having separate field circuits, of an ampere meter in the armature circuit of each machine and an adjustable resistance in the field circuit of each machine. (See illustration.)

509,518. ELECTRIC RAILWAY; Thomas A. Edison, Llewellyn Park, N. J. Application filed Aug. 14, 1891. The combination with two rails forming part of an electric circuit, of a metal conductor attached rigidly to the meeting ends of said rails, and a layer of conducting amalgam between said conductor and the rails.

509,524. POLICE AND FIRE ALARM SYSTEM; James B. Gill, San Francisco, Cal. Application filed Dec. 9, 1892. In a compound alarm system the combination with a call box of an open or ground circuit, a switchboard and annunciator, a relay controlling registering circuit, of a short circuit obtained by inserting an extra plug into an opening of the repeater.

509,530. TELEPHONIC APPARATUS; William Stuart Harrison, Hong Kong, China. Application filed Dec. 13, 1892. In telephonic apparatus, a battery or cell inserted in the circuit of the microphone, the zinc electro-positive element suspended from a lever, said lever being connected with a lever, by a link, so that when the receiver is hung on the lever the element is withdrawn from the solution, the cell thrown out of action and the microphone circuit broken, and when the receiver is taken off the element drops into the said solution, and the said circuit is closed.

509,539. ELECTRIC SWITCH; Charles J. Klein, New York, N.Y. Application filed Dec. 2, 1892. In an electric switch, the combination with terminals of a buckling plate for closing a circuit, a push piece for buckling the plate and a push piece for returning the plate to its normal position.

509,545. SIGNAL APPARATUS; George McIntosh, Stonington, Conn. Application filed Feb. 1, 1893. The combination with the signal of a plurality of commutators connected to move at different rates of speed, means for operating the commutators, an electric circuit for controlling the operation of the signal, and means for introducing one or another of the said commutators into the circuit at pleasure.

509,573. FIRE ALARM SIGNAL BOX; James M. Gardiner, Newton, Mass. Application filed Aug. 16, 1893. The combination with a fire-alarm box and a signaling mechanism therein, of an external handle, a curved plate having bearings at opposite ends, a pin on said plate acting on the non-interference mechanism of the box and an arm on the shaft of the said handle engaging with a cam surface on the said plate.

509,578. POTENTIAL INDICATOR; George A. Lintner, Minneapolis, Minn. Application filed March 16, 1893. The combination, in an electromagnetic indicator, of a core or armature, with the field portion thereof, having its windings arranged in sections or bobbins, multiple arc connections with said bobbins and a resistance provided in series with said multiple arrangement of bobbins and composed of a low temperature coefficient material.

509,603. COUPLING FOR ELECTRIC CONDUITS; Augustus Noll, New York, N. Y. Application filed Aug. 5, 1892. A coupling sleeve provided with a central enlarged portion fitted with an insulating tube and with interior recesses filled with cement.

509,614. STRAIN INSULATOR; Charles H. Dey, Boston, Mass. Application filed June 5, 1893. The combination with an insulating coupling consisting of two metallic members, capable of adjustment or movement toward and from each other when in operative position, one of which members is provided with a covering of insulating material, of a bearing or chafing surface fitted upon the insulated member and adapted to make contact with the other metallic member of the coupling.

509,616. CLAMP EAR FOR TROLLEY WIRES; Edwin B. Gates, Decatur, Ill. Application filed April 5, 1893. An ear for trolley wires consisting of two plates each having clamping jaws and intermediate spaces (the plates being adapted to act each on the other after the manner of a lever of the first class, and the jaws of each plate being adapted to act in the spaces of the other plate with a shearing tendency) and bolts and nuts to draw the plates together and thereby utilize their lever action in clamping the jaws into the trolley wire.

509,620. SHAFT MOUNT FOR ARMATURES; Samuel E. Hitt, Rockford, Ill. Application filed March 20, 1893. The combination, with an armature, of the armature shaft, a universal joint coupling or mounting for said armature upon said shaft and said armature being secured thereon to rotate with the shaft.

509,651. CLOSED CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; Emile Chabeault, Marseilles, France. Application filed Oct. 13, 1892. In combination, in an electric railway the main conductor, the car, with its current gatherer, the casing, the sliding rod therein having an upper contact and a lower conical contact, the stationary contact encircling the sliding rod, normally insulated therefrom and supported from the casing above the lower movable contact and the electrical connection from the stationary contact to the main conductor.

509,662. DYNAMO-ELECTRIC MACHINE; Carl Hoffmann, Berlin, Germany. Application filed Feb. 28, 1893. A pair of elements for the armature winding, consisting of a U-shaped bar having transversely serrated ends and a straight bar having its ends slotted to receive and retain the said serrated ends.

509,680. ELECTROMAGNETIC ALARM; Parnell Rabbidge, Sydney, New South Wales. Application filed Feb. 28, 1893. In combination a casing, a diaphragm, a solenoid, a core having its end projecting beyond the solenoid, a laterally movable spring armature located between the diaphragm and solenoid and adapted to contact with said core and a second contact point.

509,705. ELECTROMAGNETIC RECIPROCATING MOTOR; Richard Threlfall, Sydney, New South Wales. Application filed Feb. 24, 1892. In electromagnetic apparatus for producing reciprocating motion, a bi-polar electromagnet provided with both magnetizing and demagnetizing coils on each polar extremity, and a rotary commutator provided with four sets of contacts, two for each end of the magnet, for controlling the current passing through the magnetizing and demagnetizing ends.

509,713. CUT-OUT; Nathaniel F. Adams, Boston, Mass. Application filed Feb. 18, 1893. In a cut-out, a plurality of stationary members, each provided with a fuse normally included in and completing the circuit, combined with a movable member permanently secured adjacent to and to co-operate with any one of the stationary members and complete the circuit mechanically.

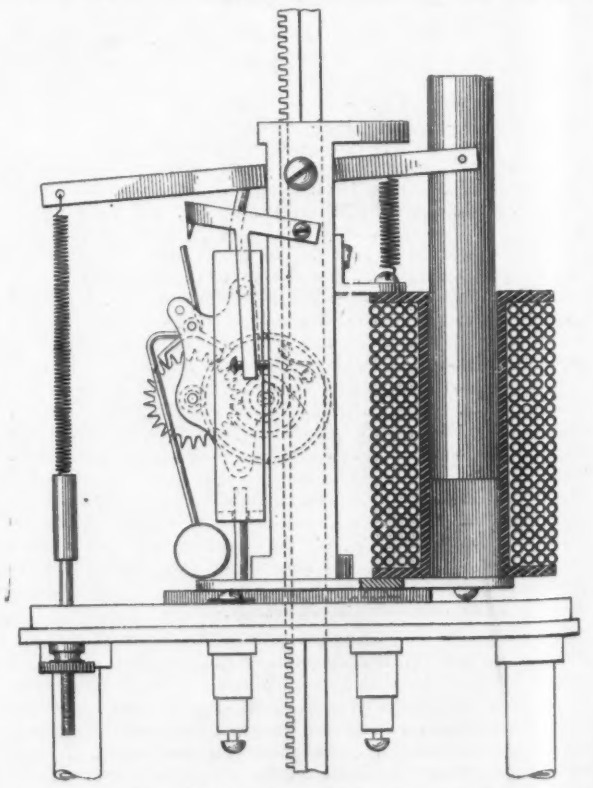
509,750. ELECTRIC CURRENT METER; William T. M. Mottram, Dallas, Tex. Application filed May 23, 1891. An electric meter, consisting of a suitable register and an electric motor controlling the same, the excitement of one of the members of said motor being the means of an independent constant source and the excitement of the other being controlled by the current to be measured.

509,770. LAMINATED CONVERTER CORE; C. F. Scott, Pittsburgh, Pa. Application filed Nov. 25, 1892. The method of forming plates for building laminated cores, which consists in dividing a rectangular strip along a continuous rectangularly broken line, so as to form two strips having teeth of uniform width and then dividing each toothed strip through the middle of alternate teeth. (See illustration.)

509,776. ELECTRICAL CONTROLLER; Elmer A. Sperry, Cleveland, O. Application filed Aug. 21, 1893. In an electrical controller having a main moving element, a current indicator forming a part thereof, a circuit therefor, a switch in said circuit adapted to be thrown during the normal movement or operation of said moving part.

509,783. LIGHTNING ARRESTER; Alexander Wurts, Pittsburgh, Pa. Application filed May 16, 1893. A lightning arrester for electric circuits consisting of a group of spark gaps, each having a resistance in series therewith sufficient, when added to the resistance of the spark gap or discharge, to cut down the dynamo current below the amperage necessary to maintain an arc across said spark gap.

509,784. UNIVERSAL NON-ARCING LIGHTNING ARRESTER; Alexander Wurts, Pittsburgh, Pa. Application filed May 16, 1893. A universal non-arcing lightning arrester consisting of two adjacent spark terminals separated by a



No. 509,842.—ELECTRIC ARC LAMP.

space too small to permit formation of a dynamo arc and a discharge wedge consisting of a tenuous conducting path of high resistance.

509,821. ELECTRIC ELEVATOR; Francis B. Perkins, Boston, Mass. Application filed March 16, 1889. In a hydraulic elevator system the combination of an electric circuit containing translating devices; a continuously running self-regulating motor placed in circuit therewith; a pressure tank to contain fluid to actuate the elevator; a pump operated by said continuously running motor and delivering into said pressure tank, and a valve actuated by pressure in the pressure tank to regulate the amount of delivery from the pump to the pressure tank.

509,842. ELECTRIC ARC LAMP; Ernest P. Clark, New York, N. Y. Application filed Jan. 28, 1893. In an electric arc lamp, a solenoid, through which alternating currents flow, whose spool or shell is composed entirely of non-conducting material and whose core is composed of iron wires inclosed in a shell of sheathing of non-conducting material. (See illustration.)

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1863—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N.Y.